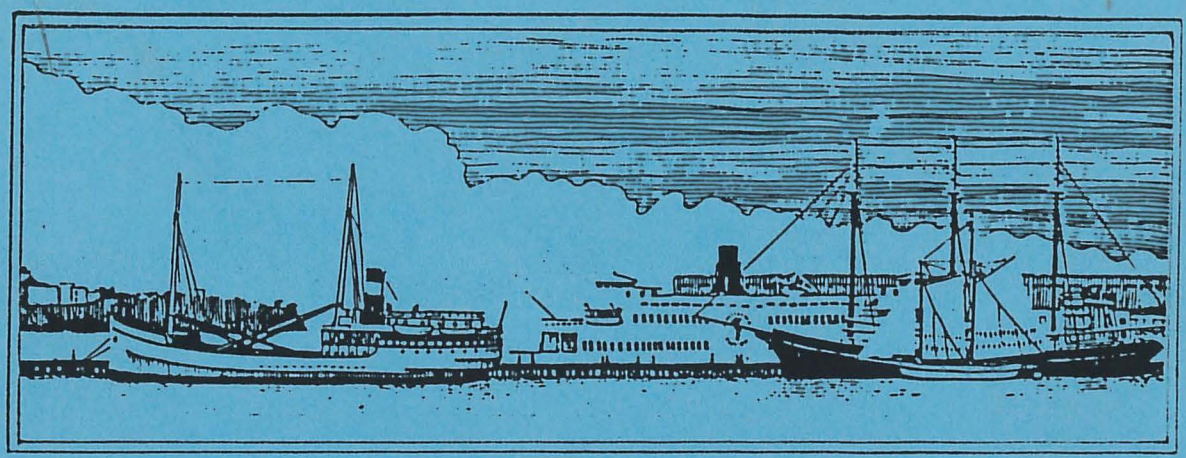


CULTURAL RESOURCES MANAGEMENT PLAN

FOR THE FLEET OF HISTORIC SHIPS

OF THE

GOLDEN GATE NATIONAL RECREATION AREA

DRAFT

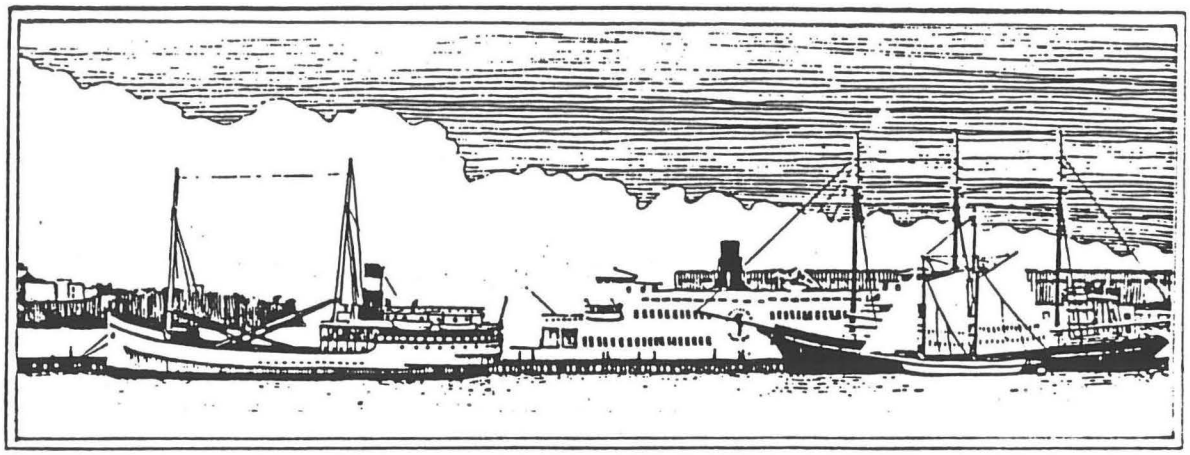
Prepared for

The National Maritime Museum at San Francisco
The National Park Service,
Golden Gate National Recreation Area
Fort Mason, Building 201
San Francisco, California, 94123

Prepared by

Tri-Coastal Marine, Inc.
2104 Strand, Galveston, Texas, 77550

January 18, 1988



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I. Preface

The Cultural Resource Management Plan, or "Fleet Plan", for the historic ships of the National Maritime Museum was commissioned by the management of the Golden Gate National Recreation Area in October of 1986. The Plan is the culmination of a series of detailed, preservation-oriented surveys begun in 1984 with the inspection of the steam ferry EUREKA.

Although most of the vessels of the historic fleet had been periodically surveyed over the years, no comprehensive data on their condition and preservation requirements was previously obtained. The surveys were generally commissioned to address specific problems, or to give a general overview of vessel condition. As these piecemeal studies were completed, it became increasingly evident that the specialized needs and deteriorating condition of the historic fleet required a thorough, comprehensive and consistent survey of each ship. The resulting coherent base of information would allow the NPS to determine priorities and ensure the best allocation of extremely limited funding. It was recognized that the surveys would be more consistent if done by a single contractor.

In January of 1984, Tri-Coastal Marine, Inc. surveyed the ferry EUREKA, and subsequently attended the vessel during drydocking and repairs. In 1985, the firm surveyed the ship BALCLUTHA and developed specifications for preservation work which was performed during her 1986 shipyard period. Also in 1985, a structural survey was performed on the steam schooner WAPAMA, as part of an Historic Structure Report commissioned by the Museum.

These surveys revealed extensive preservation needs which could not be satisfied by the existing maintenance program. Further, the practice of dealing with each ship in turn, on a one-per-year basis, meant that potentially serious problems could go undetected for extended periods, possibly resulting in irretrievable loss of original fabric. In the fall of 1986, the Museum management decided to commission surveys of the remaining vessels in the fleet; a comprehensive assessment would then be made of the fleet as a whole.

The C.A.THAYER was surveyed in October of 1986 and the HERCULES, EPPLETON HALL, and ALMA were surveyed between January and March of 1987. Follow-up inspections of the EUREKA and BALCLUTHA were also completed. The result is a relatively simultaneous picture of the condition of the entire fleet.

The surveys specifically address the problems of each vessel and put forth detailed recommendations. The Fleet Plan summarizes the findings of the surveys, addresses priorities within the fleet and presents a plan for achieving a sustainable level of preservation. Costs and scheduling are addressed in a programmatic manner. The development of detailed specifications, drawings, schedules, and budgets is beyond the scope of this study, and constitutes the next vital step.

II. Management Synopsis

The National Maritime Museum fleet of historic ships is a significant cultural resource. In size, scope, and historic relevance the collection is unequalled. Yet condition of the individual ships which comprise the fleet varies from fair to seriously threatened. The past and current levels of funding for maintenance and repair have been chronically low, resulting in an accumulation of deferred work. While essential preservation needs have been met on some of the ships, portions of others have deteriorated to the point where major rebuilding will be necessary.

The Fleet Plan establishes preservation goals based on a specific end-use for each vessel. All preservation goals are founded on the premise that the National Park Service is entrusted to preserve the fleet for future generations. The recommended usage for most vessels is restoration as floating museum ships, open to the public, but special cases range from a recommendation for stabilization only, to restoration for active use. These are explained and developed in subsequent sections of the Plan.

The funding estimates listed below are required to achieve the preservation goal established for each vessel, and a level of repair at which cyclical maintenance will sustain the vessels over the long term. The plan is developed in phases, with required funding spread over a 4 year period. Only totals for the 4-year plan are shown below.

Vessel	Preservation Goal	Funding Requirement
Alma	Upgraded for frequent sailing	$ 275,000 - 325,000
Balclutha	Fully restored, stationary museum	2,200,000 - 2,650,000
Eppleton Hall	Restored for limited steaming	1,250,000 - 1,500,000
Eureka	Fully restored, stationary museum	4,250,000 - 4,750,000
Hercules	Restored for limited steaming	1,650,000 - 2,000,000
C.A. Thayer	Partial or complete rebuild, possible limited sailing	4,500,000 - 5,350,000
Wapama	Preservation and interpretation as dry-berthed vessel.	1,800,000 - 2,400,000
Total for Fleet		**$15,925,000 -18,975,000**
Construction of adequate berthing and maintenance facilities at Hyde St. Pier		$14,200,000 -22,100,000
Total Estimated Capital Costs		**$30,125,000 -41,075,000**
Estimated Annual Maintenance for Fleet		$ 3,000,000

* Berthing and facilities estimate includes total redevelopment costs as presented in the Hyde St. Pier Concept Plan

III. A Vision

A. Philosophy for the Preservation of the NPS Fleet

The following factors form the basis for the recommendations made in the Fleet Plan:

1. The ships of the National Maritime Museum are a national treasure, five are National Historic Landmarks, and are held in trust for the people of the United States. The Park Service has been entrusted with the stewardship of this cultural resource, and is obligated to seek the means of carrying out its mandate.

2. The ships must be preserved for future generations. This is the single most important requirement and should receive the highest priority, even if some actions taken in the interest of long term preservation carry the short term cost of detracting from interpretation.

3. The public should be granted the fullest access to the ships consistent with safety and the primary goal of preservation.

4. The ships must be recognized as a threatened cultural resource. The overall condition of the fleet is declining after thirty years of museum use, and can be expected to continue to decline without substantial corrective measures. Moreover, each ship in the collection is irreplaceable. Of the thousands of their types afloat a century ago, only a handful exist today in anything better than hulk condition.

5. The City of San Francisco has a vested interest in the preservation of a fleet which is a tangible embodiment of the city's history. While nearly all major cities in the United States have grown up along a shoreline, there are few cities where the maritime trades were more crucial to founding and development than they were to San Francisco. The fleet presents a panorama of turn of the century waterfront life. International trade, coastal trades, specialized harbor work, fishing--all are reflected in the history and purpose of the vessels, and are a profile of the city's growth and identity.

6. The fleet of the National Maritime Museum is perhaps the best such collection in the world in terms of the spectrum of maritime trades represented, the historical relationship of the ships to each other, and the relevance of the collection to the region in which they are located.

7. Resources allocated to date have been insufficient to sustain an adequate level of care for the fleet, thus creating a situation of increasing deterioration. Eventually, as the vessels become unmaintainable, only major repairs or complete rebuilding will revive them, and this can only be accomplished at a much higher cost. Constancy of effort will have far more beneficial effect in long term preservation than sporadic infusions of money or labor.

8. The increased effort needed to preserve the fleet will require an improved facility. Although the vessels will continue to require periodic visits to local shipyards, the overwhelming majority of necessary work can be done alongside the pier, and can be interpreted to the public in a safe and interesting manner.

9. The National Maritime Museum represents a great community resource, having a number of educational and recreational features. A restored fleet and an improved and expanded facility will attract, and therefore serve, a larger segment of the public.

10. The National Maritime Museum has an opportunity to set a standard of excellence in the field of maritime preservation. The fleet has a visually prominent position in one of the world's crossroad cities. Good preservation work on display in San Francisco gains an international reputation. In this way, restoring the fleet will not only benefit the vessels themselves but will have the added benefit of encouraging similar undertakings elsewhere. Maritime preservation efforts throughout the country will benefit from an increase in the prestige of the National Maritime Museum.

B. Keeping Ships Alive; Maintenance, Operation, and Repair

The subsequent sections of this document outline a sequence of steps needed to bring each vessel to an optimum condition for its recommended use. In order to determine the most appropriate use, and define optimum condition, the fleet has been viewed with a long term perspective. This perspective brings to light the following:

1. Sustained Effort

The sea is relentless and remorseless in its hostility to human creations, yet it is our role to protect these historic ships, not for a given voyage or a limited time, but indefinitely. The latter point cannot be overemphasized, because it is the unique aspect of a museum ship; no other kind of vessel has such demands made of its durability. For all of the strength built into them, when viewed against the harshness of nature and the long span of years, ships are fragile to the point of being ephemeral. If this were not so, we would not now be looking at so small a muster of survivors from fleets once so vast. On this longest of voyages through time, wherein watches are stood for decades and relieved by generations, it is well to remember that these ships survived only through unremitting vigilance and constant care.

The key element to long term preservation of the historic fleet is a sustained effort. This is dependent upon preserving interest, skills, commitment, and attitudes. These in turn require creating an environment that is conducive to participation and the transfer of knowledge. It is generally accepted that the condition of a given ship is proportional to the level of activity and community interest that surrounds the vessel.

2. Operational Programs

Some of the recommendations in this study are at variance with heretofore accepted preservation practice. The most serious issue is the question of placing historic fabric at risk by utilizing a museum ship as if it were operational, either by operating the sailing rigs or engines at the dock, or by actually getting underway. In some cases, an activist approach has been taken, and recommendations have been made for restoration to fully operational condition, including limited excursion capability. These recommendations are based on the belief that a vessel with some level of operational capability will generate greater interest and participation from the community. The benefits achievable with such usage merit acceptance of some level of risk of accidental loss or damage, in return for reducing the greater risk of loss through neglect and decay. Operational programs are recommended only where they are deemed to be beneficial to the long term preservation of our maritime heritage.

3. Original Fabric

The process of maintaining a ship which is afloat and exposed to the elements involves renewals of fabric on a gradual basis over many years. Blind adherence to the practice of retaining original fabric can, in time, threaten the survival of an historic ship. The integrity of the ship through time is best preserved by concentrating effort on the authenticity of repair methods. Long term retention of original fabric is best achieved by consistent maintenance and timely repair, which in turn require a high level of hands-on involvement.

C. The fleet in five years

The following recommendations for each vessel are more fully discussed in the individual vessel sections. The recommendations reflect the foregoing discussion in that the emphasis is on achieving a level of activity that reaches a wider public, expands interpretation, and encourages volunteer participation, all of which will foster a high level of long term support for the preservation of the fleet.

ALMA - 60', wood, scow schooner, 1891

The ALMA has had extensive rebuilding over the years and has been sailed on a limited basis. A considerable amount of renewal is still needed for long term preservation. Recommendations include fully restoring the vessel and upgrading her operation to a daily passenger carrying service that can be be financially self-sustaining. Increasing the sailing schedule will justify a full time crew, thereby greatly improving the maintenance of the vessel.

BALCLUTHA - 256', steel, full rigged ship, 1886

In 1986 some of the BALCLUTHA's most serious problems were corrected during a major shipyard visit, but a great deal still needs to be done to arrest her deterioration. Due to her size and the complexity of her rig, it is not considered feasible or advisable to restore the vessel to sailing condition. Large engineless square-rigged vessels such as the BALCLUTHA are only suited to offshore operation; recreating such an operation would be extremely costly and represent an unwarranted level of risk. Recommended, however, is an increase in the usage of the vessel to the extent of fitting her with a minimal suit of sails (lower topsails and stay-sails), and conducting a dockside volunteer sail-handling program that would encourage volunteer participation in maintenance and provide a greatly increased level of interpretation.

EPPLETON HALL - 105', steel, steam paddle wheel tug, 1914

Despite the fact that the Eppleton Hall does not qualify for the National Register and is not directly related to U.S. Maritime history, she is the lone survivor of an important type. We believe that she should be recognized as historically significant, and a responsibility acknowledged to at least stabilize and preserve her. Restoring her to steaming condition (she was last operated in 1979) would allow the fullest appreciation of the vessel, and may best be done by cooperative agreement with a private non-profit organization.

EUREKA - 300', wood, steam sidewheel ferry, 1890

The EUREKA operated out of her present slip until 1956 and was acquired intact and unaltered. While her hull and machinery are still in basically good condition, deterioration of her superstructure is reaching critical condition. As the superstructure deteriorates, the hull will suffer in turn. If her problems are not addressed soon, it is likely that the degree of rebuilding needed to restore her will be extensive if not entirely prohibitive. Beyond correction of structural problems, we recommend getting steam up on one of the four boilers for interpretive dockside operation of her machinery.

HERCULES - 150', steel, steam screw tug, 1907

The HERCULES is in relatively good condition and will require a relatively small degree of restoration to make her capable of limited steaming operations. She is an ideal vessel for extensive volunteer participation. She should be opened to the public, as well as being steamed occasionally in a parallel program with the JEREMIAH O'BRIEN.

C.A.THAYER - 156', wood, 3-mast lumber schooner, 1895

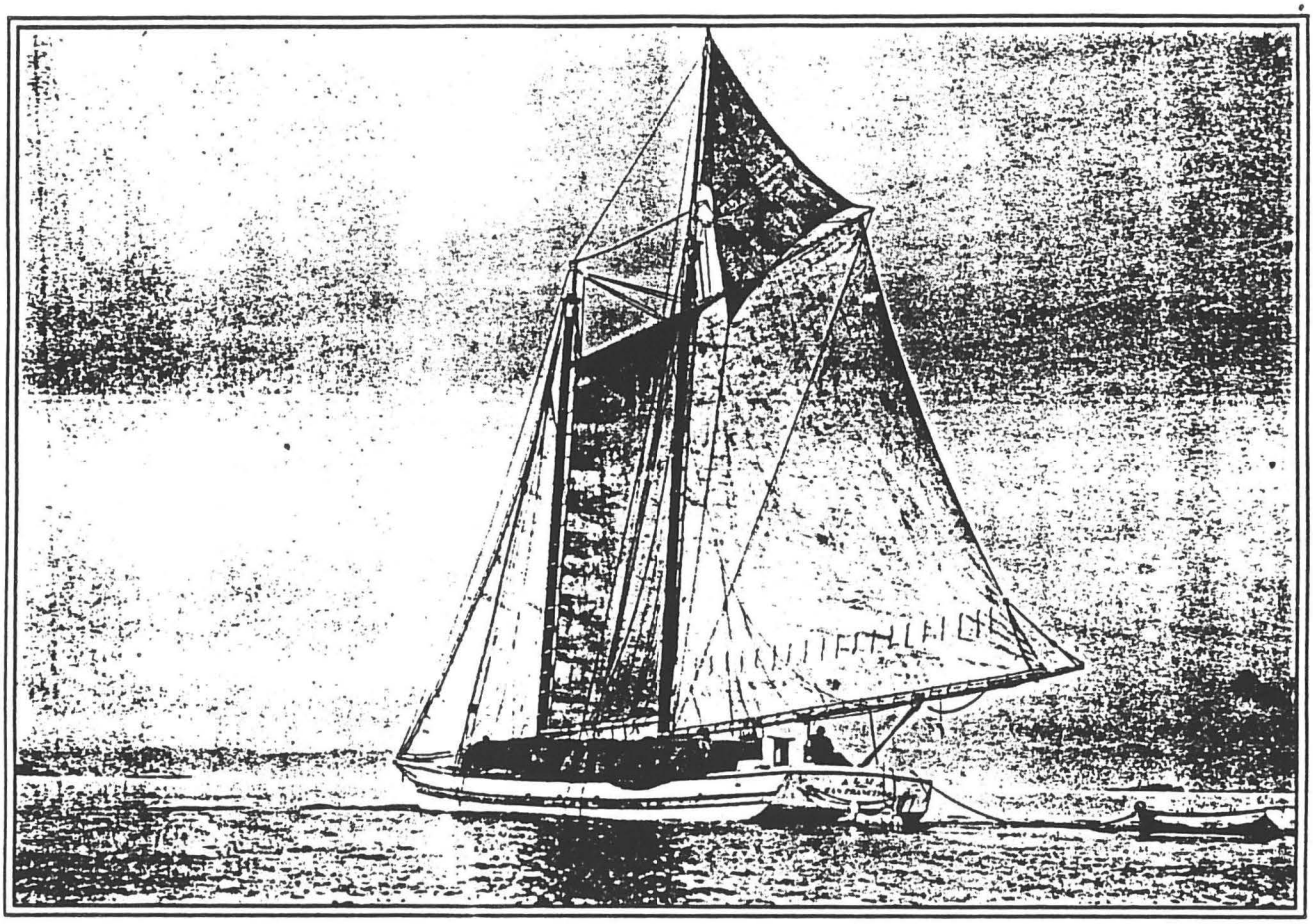
This vessel was sailed from Seattle to San Francisco in 1957, when she underwent significant restoration for inclusion in the State historic fleet. She has since deteriorated, and requires major rebuilding. The scope of work needed is similar to that of the WAPAMA, but should be an easier task as she is only 30% of the WAPAMA's size. It is considered possible and advisable that the rebuilt vessel be sailed conservatively once or twice a year, a key element in attracting volunteer maintenance to supplement staff efforts.

WAPAMA - 217', wood, steam schooner, 1915

The WAPAMA Historic Structure Report of 1987 recommended against rebuilding the vessel to floating condition. Rather, it was recommended that she be stabilized for permanent out-of-the-water storage with limited restoration, permitting some level of public access and interpretation.

Small Craft Collection

This collection is rich and varied. Some of the boats are fit for demonstration use, while others must be considered fragile and solely for display or storage and documentation. Programs in this extremely important area of maritime history can be expanded, including interpretation, research, replication and skills preservation, and, at a rebuilt Hyde St. Pier, an active on-the-water training and recreation program.



ALMA underway, circa 1900

A. The Scow Schooner ALMA

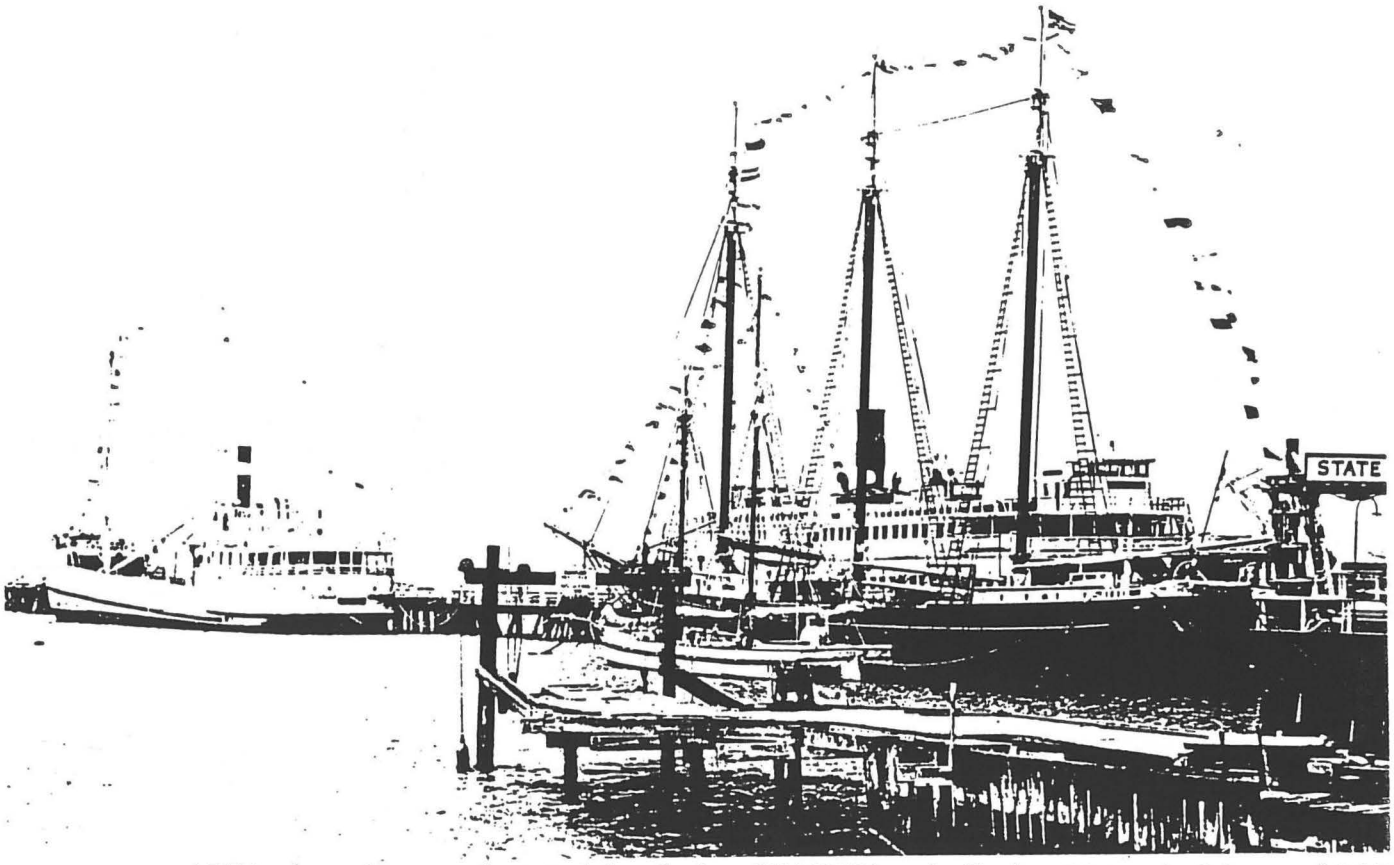
1. Particulars

Registered Length:	59 ft.	Max. Draft:	2.75 ft. with board up
Length Overall:	80 ft.		15.75 ft. with board down
Beam:	22.60 ft.	Molded Depth:	5.25 ft.
Gross tonnage:	41.76	Net tonnage:	39

Built: Fred Scimer, San Francisco, 1891, for James Peterson
Hull, decks, cabin and spars: wood

Rig: two-mast schooner, gaff rigged on fore and main masts, gaff topsail on main

Machinery: diesel auxiliary engine (later addition)



ALMA (center, alongside C.A. THAYER) at Hyde Street Pier, 1963

2. History and Relevance

ALMA is the last survivor of a class of over 400 vessels which once carried a large portion of the local farm-to-market and small commercial trade around San Francisco Bay and its tributaries. Scow schooners were in operation well into the first decades of this century, until the development of roads and trucking replaced their service, and the need for their principal cargo: deck loads of hay, to feed the horses of a growing pre-motorized city. These strongly-built, flat-bottomed, centerboard craft were navigated by their two or three-man crews into the remotest tidelands and sloughs of the bay and delta. There they delivered supplies and collected hay, grain, fruits and vegetables, eggs and other farm products, building materials, and other cargos. The scows were a familiar sight in this watery region, often seen with booms topped above their high deck loads. ALMA served this trade for many years before being converted for use as an oyster dredge.

3. Preservation History

In 1960 the ALMA was purchased by the State of California and restored to her original sailing configuration, though with an auxiliary engine. She was maintained and sailed periodically from her berth in the Aquatic Park by a volunteer organization, "The Friends of the Alma". Although her condition deteriorated considerably during several years of idleness, recent repairs and re-rigging have returned her to an operational status. She now lies on a mooring in Aquatic Park lagoon, and is not accessible to the public.

4. Recommended Use

Creating a program by which the ALMA would carry paying passengers, in a greatly increased and self-sustaining program, is recommended. At the present time, the ALMA is the only vessel in the fleet which can be sailed, and is operated on excursions several times each year. The sailing program adds real life to the museum, but as presently constituted, requires shifting crew from other projects and is accessible to a relatively small number of NPS guests. Under the recommended usage, the Museum would gain the benefit of an operational program without an increased burden on the staff.

Strictly speaking the ALMA is a government owned vessel and exempt from United States Coast Guard inspection. However, any plan to charge fares for passage may require compliance with the applicable Coast Guard regulations. This is a matter for legal investigation. On a practical level, the vessel and her passengers will be far safer if regulations are complied with, and the ALMA achieves Coast Guard certification.

The case for maximizing the operational use of the ALMA is based on the following points:

- The care and maintenance of the vessel would be vastly improved by the regular attention of staff whose primary responsibility would be to keep her in safe sailing condition.

- The earned income potential would be sufficient to make the vessel self-sustaining, including operation and maintenance.

- The opportunity to sail as crew in ALMA can greatly increase the level of seamanship and shipkeeping consciousness among NPS staff and volunteers. The program could provide one or two crew positions through which interested individuals could rotate. This system could boost morale and training simultaneously.

- A much wider segment of the public can be reached. At present the public cannot get aboard. Even if they could, the vessel's size would offer limited interpretation opportunity. ALMA, sailing on a daily basis, may provide a high quality experience to thousands of people a year. Her passages along the waterfront and across the Bay would bring her to the attention of tens of thousands of people who otherwise would not know of her existence, or that of the fleet at Hyde St. Pier.

There are also some drawbacks to an operational program which, though felt to be outweighed by the benefits, should be mentioned.

- Continuous usage presents a greater degree of risk of accident than does idleness in Aquatic Park. Based on the operational records of small traditional schooners of similar size, the risk is not considered to be great. This risk must be recognized, however, and all due precautions taken.

- Capital expenditures will be needed. The vessel requires numerous structural repairs, as noted in the ALMA Survey Report. In addition, modifications and improvements to the existing equipment will be required for compliance with the rules of Subchapter "T" of U.S. Coast Guard regulations for small passenger vessels. The structural repairs are needed in any case, but the latter requirements would not be necessary for preservation of the vessel.

- A program of greatly increased use will carry an administrative burden. This could be partially offset by entering into a cooperative agreement with a non-governmental entity.

5. Existing Condition

a. Summary

The scow schooner ALMA is in fair condition considering her age and type of construction. Significant structural repairs were undertaken during haulouts in 1986 and 1987, yet rot remains in several areas and some deteriorating conditions still exist. The demands placed on ALMA by operation as an active sailing vessel warrant a higher level of maintenance than that required for an inactive floating museum vessel. She will therefore require a minimum level of repair in order to operate safely in the coming sailing seasons. In addition, several non-critical deficiencies should be corrected in order to improve ALMA's operational capacity and prevent further deterioration. Some repair work will have to be performed at haul-out and would presumably be done under contract. Other work can be handled by NPS staff while the vessel is in the water.

b. Hull

Two general conditions are seen in the hull structure: 1) soft rot on the surfaces of stringers, frames and planking, and 2) dry rot in tops of stringers, in the interior and on outboard faces of frames, and on inboard surfaces of some planking.
The worst conditions found in the 1985 and 1986 surveys were in the **stern area**, where several frames and planks were severely rotten. These conditions were corrected during haulout in the spring of 1987, at which time the entire stern was rebuilt.

The **bow structure** is in better condition, though the centerline bow frame is partially rotted, and there are local areas of decay in other bow frames. The **keelson** is severely deteriorated in way of the foremast. As a result, the heel of the foremast is crushing into the keelson.

The **longitudinal bottom stringers**, the main strength members in the bottom, show considerable softening, but retain some integrity.

The ceiling is generally rough and soft in places. The centerboard bed log timbers and the lowest centerboard trunk side members show severe soft rot decay on both port and starboard sides.

The hull sides underwent some work during haul-out in 1986. This work included renewal of planking and sistering of some side frames. The primary area of concern is soft side planking which was not renewed during the last haul-out. The clamp, which is rotten in several locations, broken on the port side, and nail sick at fastenings all along, is also a concern. A doubler has been added to the starboard clamp, in way of the hatch. This piece has also become soft at the fastenings. The side framing is generally soft at the lower ends. Most frames have been sistered, though with inadequate fastening.

c. Deck

Although most of the deck appears sound, scattered areas of rot exist. The worst area is across the forward side of the hatch where at least 50% of the **deck planks** are rotten at the ends. The margin plank at the forward starboard corner is rotten to 6 ft. abaft the bow. Several butts sound hollow throughout the deck. Portions of severely rotten decking aft of the cabin trunk were renewed in 1987.

Most **deck beams** are in fair condition, though a few show severe rot. The **hatch coaming** is rotten at the starboard forward end, and soft at the port forward and starboard aft ends. The synthetic fabric hatch cover and the hatch boards and battens are in good condition. Widespread rot was seen in the **bulwarks**, most of which is centered around butts, corner joints, and fastenings. The **cabin trunk** is a recent addition and is in good condition.

d. Rig

The rig is in generally good condition. All **spars** are less than ten years old and show little sign of deterioration.

The **standing rigging appears** in good condition overall, with a few areas suffering from lack of maintenance. The parceling is rotting on the main shroud eyes and all eyes are in need of tar. Much of the fiber **running rigging** is weathered, and should be replaced. The sail inventory is in serviceable condition.

Regular maintenance, including tarring, painting, varnishing, and filling of checks, will be necessary to prevent deterioration of rigging and spars.

e. Machinery and Equipment

Engine and reduction gear: The engine underwent overhaul in the fall of 1986. Both engine and reduction gear appear to be in good running order.

Fuel tank: The tank itself appears to be in good condition, but the filler pipe is badly corroded.

Electrical system: The electrical system is limited to the engine compartment and cabin areas. Much of the wiring appears new, is an approved type, and is properly secured. Modifications would be necessary to meet U.S. Coast Guard regulations.

Ballast: Chain ballast has been stowed below, primarily for trim. This chain is severely corroded and is not secured.

Safety Gear: ALMA meets U.S.C.G. requirements (for yacht) in all categories, including fire extinguishers, life preservers, navigational gear, and emergency signaling equipment.

6. Recommended Steps

The highest priority for ALMA's preservation is the repair of deficient hull structure. This work includes renewal of centerboard case bed logs, repairs to longitudinal bottom stringers, clamps, selected side framing, selected bottom and side planking, and the forward section of the keelson. Secondary priority work will encompass renewal of the bulwarks, some deck planking, and some deck beams. Since these projects probably will not be completed for several years, a rot arresting program is recommended immediately.

If a decision is made to seek certification as an inspected vessel for passenger work, the processes of plan submittal and approval, inspection and certification, staffing and operational planning will probably take about one year to complete, but could be spread out over two or more years.

In its present condition, the vessel is considered reasonably safe to operate. The highest priority preservation needs, repairs to the hull, should be addressed in the near future in order to allow the present limited daysailing program to continue in a safe manner. The remainder of the structural repairs should be scheduled in the next two to three years. If a passenger for hire program is pursued, all hull repairs will need to be completed, as well as other U.S.C.G. requirements, prior to achieving certification.

Whether or not an intensive sailing program is undertaken, the installation of a suitable berthing facility should be considered. This would take the form of a floating dock, which would allow ALMA to be boarded easily, and land and depart with convenience.

7. Table of Cost Projections, ALMA recommendations

a. Schedule of Fiscal Preservation Costs

The following schedule of costs includes items required for U.S. Coast Guard certification, as well as those necessary for preservation, whether or not the vessel is made fully operational.

FY 88: Highest Priority Preservation Work, and Planning	
1. Repair centerboard bed logs, repair keelson	$ 50,000
2. Planning work for C.G. Certification	$ 10,000
Total for Year #1	$ 60,000
FY 89: Additional Preservation Work	
1. Renew clamp, side frames; repair longitudinal stringers	$ 70,000
2. Renew ceiling, build ballast boxes, replace ballast	$ 25,000
3. Consulting for C.G. Cert.	$ 5,000
Total for Year #2	$100,000
FY 90: Completion of Preservation Work	
1. Renew Bulwarks	$ 60,000
2. Partial renewal of deck planking and beams, misc. repairs, side and bottom plank renewals	$ 35,000
Total for Year #3	$ 95,000
FY 91: Modifications for C.G. Certification	
1. Mods. and equipment, certification	$ 65,000
Total for Year #4	$ 65,000
Total for 4-year Program	$320,000

Note: Estimates are based on $40 per hour for work requiring shipyard contracts, $30 per hour for work which can be accomplished by staff.

b. Breakdown of ALMA Upgrade Costs for Compliance with Subchapter T

Preliminary Cost Estimates

Required Item	Estimated Cost
Plan submittal to U.S.C.G.	$ 7,500
Calculations & inclining experiment	2,500
Hull Inspection, COTR assistance	1,500
Vessel modifications:	
1. 1 Toilet, approved MSD, modular	5,000
2. 30 - 36" rail, perimeter of vessel Accessible to Passengers:	2,000
3. Life preservers (PFD's) for all persons, including children	1,500
4. Deck Boxes for PFD's	1,000
5. 2 Man-Overboard ring buoys	250
6. Fire/bilge pump power driven	existing
7. Garden hose & nozzle for fire hose	existing
8. Fire extinguishers (3)	existing
9. Fuel tank (may need to be renewed), tank piping & venting, and remote shutoff valves	3,000
10. Vent ducts (2) to machinery space	500
11. Vapor tight barrier to passenger spaces	2,000
12. Bilge suction line 1" or greater	1,000
13. Bilge/Fire hand pump (1)	existing
14. Emergency steering	existing
15. Electrical system upgrade	5,000
16. Life rafts	10,000
17. Navigation lights upgrade	2,000
18. Radio	existing
19. Upgrade float, brow, moorings	20,000
	$ 64,750

The above cost estimates are based on a general interpretation of the Subchapter T requirements, and familiarity with the vessel. A more detailed estimate will require drawings, specifications, and formal consultation with the U.S. Coast Guard.

c. ALMA Operating Expense Projections

The following analysis of a maximum usage program is a preliminary model only.

Operating Schedule

1.0 months per year:	maintenance & preparation
8.0 months per year:	sailing
.5 months per year:	lay-up
9.5 months total	

Sailing Season

Slack Season: 3 Months (June, July, August)

5 day week, with 3 trips per day = 15 trips per week

High Season: 4 Months (April, May, September, October)

7 day week, with 3 trips per day on weekdays, 4 trips per day on weekends = 23 trips per week
(Two crews needed for this schedule)

Trip length: 2 to 2.5 hours

Crew Costs

Crew Member	Cost (wages and payroll tax)
Operator	$ 12.5 per hour / $ 500 per wk.
Mate	9.0 " " 360 " "
Hand	7.0 " " 280 " "
Hand	7.0 " " 280 " "
	$ 1420 per w.k
+ 15% overhead on payroll =	213
Total crew cost =	$ 1633 per week

Program Budget

Crew: First crew for 42 weeks x $1633 per wk. =	$ 68,586
Second crew for 16 weeks x $1633 per wk. =	26,128
	94,714
If 1 hand is a volunteer:	- 20,000
	$ 74,714

ALMA operating expense projection, continued:

Administration:	Ticket Sales Accounting Advertising Phone, Utilities, etc.	$ 25,000
Consumables:	Fuel - 2,000 gal @ $1.00 gal.	$ 2,000
	Engine oil & spares	500
	Sail Fund - $ 12,000 per suit (amortized over 5 years)	2,500
	Rig Fund (amortized over 3 years)	1,000
	Mooring lines, fenders, etc.	1,000
		$ 7,000
Other Expenses:	Insurance	$ 20,000
	Drydock Fund (maintenance only)	4,000
	Hull Repair Fund	8,000
		$ 32,000
Total Annual Program Cost		$ 138,714

d. Alma Sailing Schedule - Income Potential

Sailing 7 months per year:

13 weeks, sailing 5 days per week, 3 trips per day	=	195 trips
16 weeks, sailing 7 days per week,		
3 trips per day on weekdays	=	240 trips
4 trips per day on weekends	=	128 trips
Total possible trips		563
20% Cancellations (allowing for weather and machinery failure)	-	113
Realistic Max Schedule of Trips		450
Trips devoted to PR and Associated Functions	-	34
Revenue Producing Trips		416

The highest theoretical earning potential is as follows:

40 passenger max. at $15 each = $600 per trip

$600 per trip x 416 trips = $249,600 gross annual income.

A more realistic earning projection would be somewhat less than this figure. An estimate of the minimum earning potential would take into consideration:

- Discounts for children, seniors, families, etc. resulting in reduction of average ticket price to $12.00 per person, therefore reducing earnings to $ 480 per trip maximum.

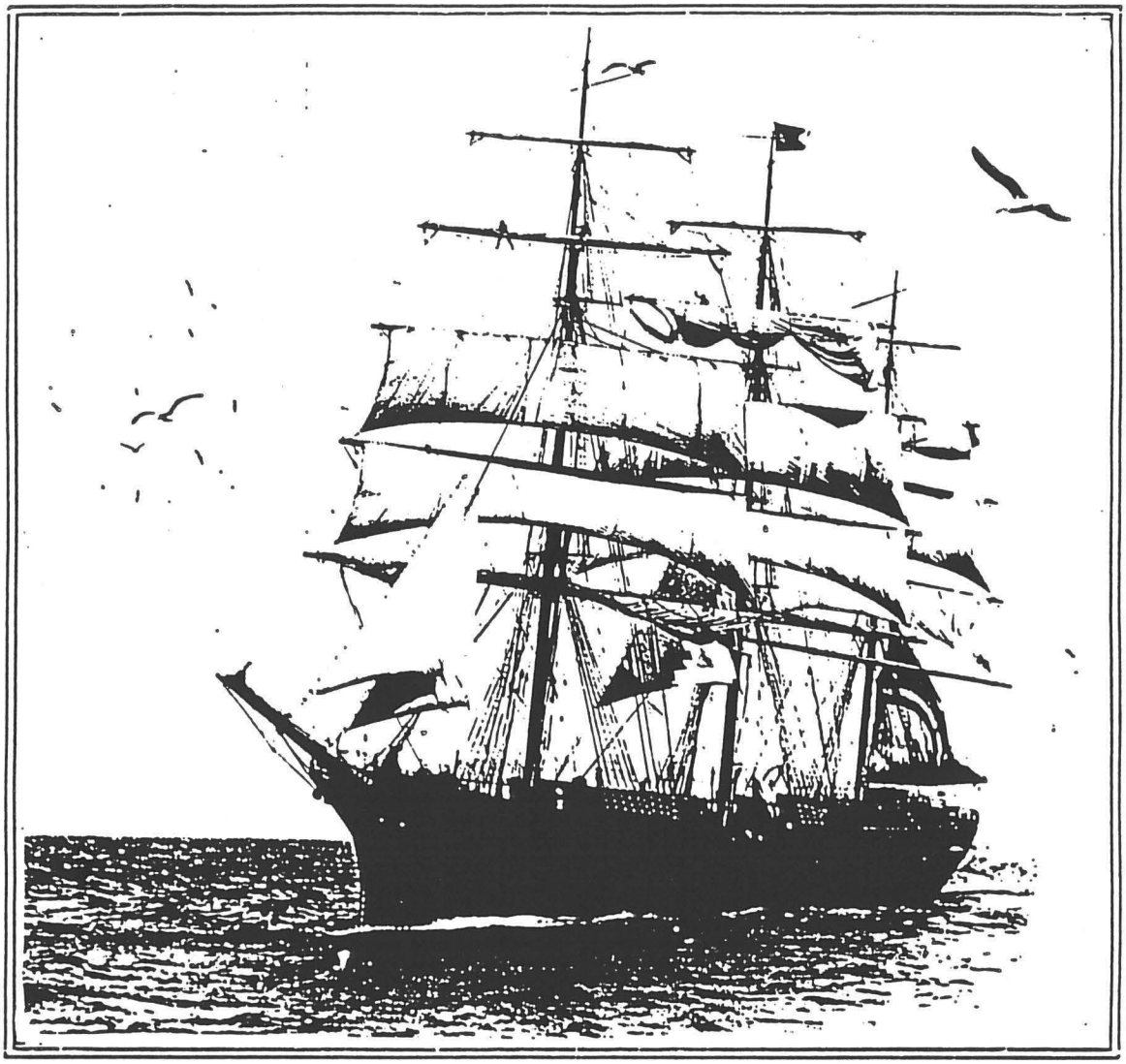
- Expectation of trips with less than full capacity. The higher percentage of revenue earned per trips is likely to be concentrated in the best weather. A realistic distribution, based on 416 revenue producing trips per year, with maximum capacity of 40 persons at $12. per person, would be as follows:

10% at	100% cap.	= 42	trips	x $480	=	$ 20,160	1,680 persons
20% at	75% cap.	= 83	"	x 360	=	29,880	2,490 "
40% at	50% cap.	= 166	"	x 240	=	39,840	3,320 "
20% at	25% cap.	= 83	"	x 120	=	9,960	830 "
10% at	10% cap.	= 42	"	x 48	=	2,016	168 "
						-------	-----
Average gross annual income						$101,856	
Total passengers carried							8,488

The actual income earning potential of the outlined ALMA sailing program would probably fall somewhere between the above figure of $101,856 and the theoretical maximum of $249,600.

8. References

J. Ehrhorn Survey, Jan. 1987



BALCLUTHA, as STAR OF ALASKA, clears the Golden Gate.

B. The Full Rigged Ship BALCLUTHA

1. Particulars:

Length:	256.30 ft	Gross tonnage:	1689
Beam:	38.50 ft	Net tonnage:	1590
Max. Draft:	22.70 ft	Present Draft:	13.00 ft. average

Built: Charles Connell & Co., Glascow, Scotland, 1886, for Robert McMillan, Dumbarton, Scotland

Hull and superstructure: Riveted steel and iron

Decks: Wood

Engine: none

Rig: Full-rigged ship; Double topsails, single topgallants. Steel unitary lowers and topmasts; steel lower yards, fore and main topsail yards, and spike bowsprit. All other spars, wood.

2. History and Relevance

Although built in Scotland and operated around the world under the British flag for her first 13 years, BALCLUTHA's history is intimately connected with that of the Port of San Francisco, and the State of California. Her maiden voyage brought her to San Francisco to join the fleet of deepwater square riggers loading wheat for Europe. She is a fine example of that penultimate generation of steel sailing merchantmen produced in Britain and Europe, before the development of the large barques which were the final evolution of long-distance trading under sail.

After achieving registry as a U.S. flag vessel in 1901, by way of the annexation of Hawaii, she entered the Pacific lumber trade to Australia. In 1906, she joined the "Star" fleet of square-riggers of the Alaska Packers Company of San Francisco, at which time her name was changed to STAR OF ALASKA. In this service, she made yearly trips north to Alaska with fishermen, cannery workers and supplies, returning them at season's end with the Packers' catch: a cargo of canned salmon. Between seasons she was laid up with the rest of the company's fleet in the Oakland estuary.

The Alaska Packers modified her for this work by extending her poop deck forward almost to the main mast, forming a shelter deck for the accommodation of fishermen. A portion of her 'tweendecks was also fitted to accommodate the predominately Chinese workers in transit to the canneries.

BALCLUTHA served the Alaska Packers until 1930, in one of the last trades in America to use square riggers. In her 44 years of active life she was involved with California, West Coast and National history, with American agriculture, lumbering, and fisheries, and with the growth of the port of San Francisco. She well deserves her status as a National Historic Landmark.

3. Preservation History

BALCLUTHA's career as a museum ship began inauspiciously in 1933, when she was towed from the idle "Star" fleet, which comprised the last great collection of working square riggers in America, to be shown as a "pirate ship" along the West Coast under the name PACIFIC QUEEN. This theatrical venture ended with her lay-up in the shallows of Richardson Bay, her hull badly rusting and her rigging in disrepair, but still nearly a complete ship.

The San Francisco Maritime Museum was founded in 1950 with offices, storerooms and exhibits in the Aquatic Park Casino building. The BALCLUTHA was the Museum's first major floating acquisition. With donated labor from 18 labor unions and help in cash and kind from over 90 corporations she was largely restored to her state as a British merchantman (though the extended poop deck was retained). The ship was opened to the public in 1955 at Pier 43, a highly visible site adjacent to Fisherman's Wharf. Interpretive panels on deck explained the workings of a square-rigger, and a museum in her 'tweendecks addressed the history of the ship, the Alaska Packers, the city of San Francisco, and maritime history in general. The exhibit included figureheads, portions of the rigging of other vessels, historic ship's hardware, and assorted maritime artifacts. Her accommodations and deckhouse spaces were restored, furnished and dressed, visible behind protective partitions.

BALCLUTHA became a model and source of encouragement for ship restoration projects throughout the world. Her restoration was accurate and her interpretation and exhibits, though now perhaps dated graphically and uncertain as to scope, were informative and entertaining. Revenues from the ship's admission charge were enough, it seemed, to support not only her own maintenance, but that of the collections and exhibitions of the Maritime Museum as well.

BALCLUTHA's salvage and restoration was neither easy nor cheap, and her successful operation as a waterfront attraction for over 30 years was no minor accomplishment. The project benefited from its start, however, with a fairly intact vessel, the absence of a large debt burden, municipal help with salaries and space, and a location with extremely high tourist traffic. Demands placed on the earned income by the daily maintenance and operation of the vessel and by other Maritime Museum needs, however, resulted in deferral of cyclical maintenance, such as drydocking.

BALCLUTHA remained a part of the Maritime Museum while the other vessels of the State historic fleet were being assembled, restored and opened to the public. In 1977, both the State fleet, and the Maritime Museum came under the aegis of the National Park Service. As part of the nation's largest collection of historic ships and the major maritime historical facility on the West Coast, BALCLUTHA'S continued preservation, interpretation, maintenance, funding, and even her location must once again be considered within a broader context--the broad context, in fact, which was the founding vision of the Maritime Museum.

4. Recommended Use

For over thirty years BALCLUTHA has been one of the most successful museum ships in the world. She should continue serving the public in this manner. Current plans call for relocation of the ship from her present berth at Pier 43 to the Hyde St. Pier in the spring or summer of 1988. This move is being undertaken primarily for reasons of safety, but it will also benefit interpretation of the fleet as a whole. The ship currently is maintained by NPS, though collection of admission fees and janitorial service is provided by the Maritime Museum Association, a private non-profit organization, who administer the earned income. Relocating the ship to Hyde St. will require an engineering study and mooring plan, installation of moorings, modifications to utilities and brow, a safety upgrade of the Hyde St. Pier, and an arrangement regarding collection and distribution of admission fees.

During BALCLUTHA's 1986 drydocking and cyclical maintenance, many of the serious deficiencies identified by the 1985 survey were corrected, but due to limited availability of funds, some important work was deferred. Much of this work is essential to the preservation of original fabric, and should be completed over the next few years (see Section 6, "Recommended Steps").

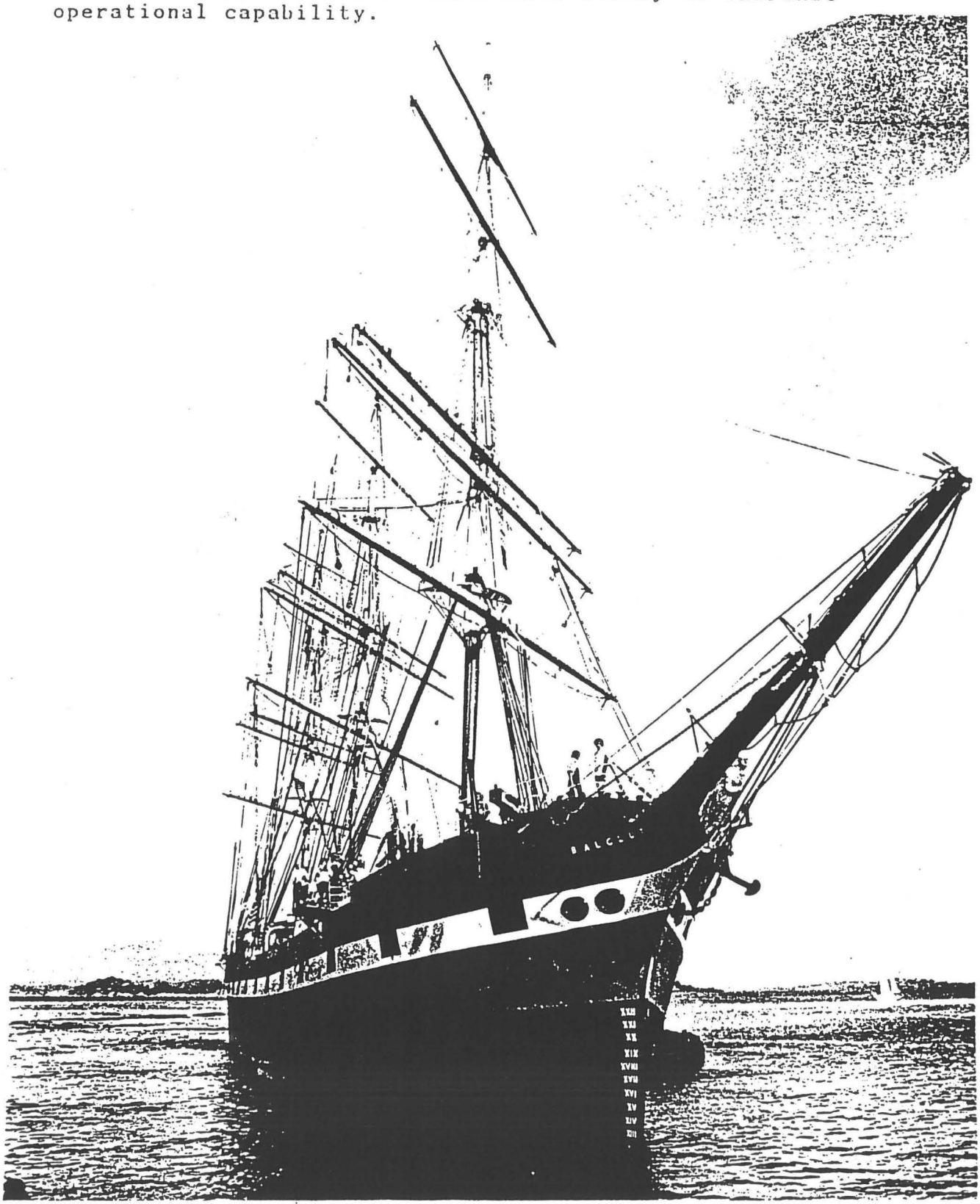
Beyond completion of the work needed for physical preservation, recommendations include restoring the running rigging to the extent that lower topsails and a staysail or two can be set. This would be primarily for interpretive purposes, and would enhance the ship's appearance, as well as providing live interpretation. These sails should be of a minimum weight and strength to ensure that they would give way, before straining the spars and standing rigging, in the event of severe winds.

Introducing this level of activity will require recruiting a volunteer crew who, it is hoped, will take an interest in supplementing the staff effort at rigging maintenance. The more people become accustomed to working aloft the better off the ship will be. Participants and spectators alike can learn much from regular sail drills.

Sailing BALCLUTHA is not recommended, nor is it deemed necessary to restore her to sailing condition. Even if her present condition permitted limited excursions, operation of the ship would be difficult; San Francisco Bay is not the easiest place to sail a large, engineless, full-rigged ship. Although she would probably be safer to operate in the open ocean than in the Bay, such an undertaking would be expensive and carry risks that would be difficult to justify.

BALCLUTHA has a higher proportion of original material and fittings than any other square-rigged museum ship in the United States, and may be the most intact example of her type anywhere. For this reason, she is an extraordinarily valuable artifact, and a high level of caution is recommended in her use. Although

repair and renewal of original fabric is unhesitatingly recommended where necessary to preserve the ship, this work is not deemed appropriate if undertaken solely to increase operational capability.



BALCLUTHA returns to her exhibition berth after a haul out, 1981.

5. Existing Condition

a. Summary

BALCLUTHA was surveyed in 1985 and specifications were developed for the most urgently needed repairs. In 1986, the vessel was drydocked and approximately $500,000 of repair work and coatings upgrading was completed. The ship overall is in fair condition for the intended use as a stationary museum ship. An assessment by area is as follows;

b. Hull

Most of the wind and waterline area has been doubled with welded plate, some of which was installed during the 1986 drydocking, and some dating back to the 1960's. About 15% of the shell is now doubled, and no bottom plating less than 1/4" thick remains exposed. Numerous instances of severe pitting due to electrolysis were found on the hull exterior below the waterline. In addition, several holes were found, and considerable wastage was seen on rivets and along plate seams. During drydocking, many of these pits and wasted rivets, and all of the seams, were filled with epoxy. The holes were filled with a special compound, or were doubled over with steel patches. The bottom was sandblasted, a high quality coating system was applied, and a series of replaceable sacrificial anodes installed.

Inside the hull, the bilges in the hold were cleaned and about one third of the cement liner was removed in order to address active corrosion beneath. These areas were scaled, coated, and recemented. The bilges above the cement were recoated with preservative film, but at some point it will be advisable to completely remove the cement liner and coat the shell directly. The bilges in way of the chain locker and the forepeak were not addressed during the last drydocking. Their condition is believed to be marginal.

The topsides were painted, and the rudder was unshipped for overhaul and rehung. A section of wasted keelson under the mainmast was repaired as well.

The steel hull structure suffers from wastage of stringer plates, and loss of riveted attachment along the edges of the main deck and 'tweendeck. In addition, portions of the hold stringers are severely wasted and detached. These conditions are due to corrosion, caused primarily by water seepage through the cement waterways. The overall strength of the hull is estimated at 50% of original, and is felt to be sufficient for the present use of the vessel.

3. **Renew sections and riveted attachment of hold stringers.** In addition to loss of riveted attachment, sections of these longitudinals are severely wasted and cannot be refastened without partial renewal. As with the deck stringers, these repairs are not essential, but the strength of the hull will be improved if they are carried out.

4. **Repair or renew 'tween deck planking.** The 'tween deck has been used as a museum gallery since 1956, and for this purpose, the original rough planking was sheathed with linoleum. Chronic leakage of the main deck over the years has resulted in the development of rot in the 'tween deck planking in numerous locations. If the linoleum were removed, the deck would likely be unsafe for foot traffic due to roughness and unevenness of the surface. Stopping main deck leaks should slow the rate of deterioration, particularly if combined with rot arresting chemical treatment. Eventually, however, portions of the deck will become too weak for visitor safety and will require renewal.

FY 91: Non-essential Work

1. **Set up running rigging on lower topsail yards and stays; make and bend on topsails and staysails.** These sails would be regularly set for public demonstration and for the recruitment and morale of volunteers. A training program enabling people to work aloft will go a long way to further the maintenance of the rig.

7. Table of Cost Projections, BALCLUTHA

FY 88: Highest Priority Preservation Work

a.	Renew center section main deck	$ 120,000
b.	Recaulk forecastle head deck	$ 15,000
c.	Repair deckhouse	$ 40,000
d.	Upgrade electrical system	$ 50,000
Total for Year #1		$ 225,000

FY 89: Additional High Priority Work

a.	Overhaul standing rigging and spars	$ 675,000
b.	Remove remaining bilge cement and recoat	$ 380,000
Total for Year #2		$ 1,055,000

FY 90: Secondary Priority Work

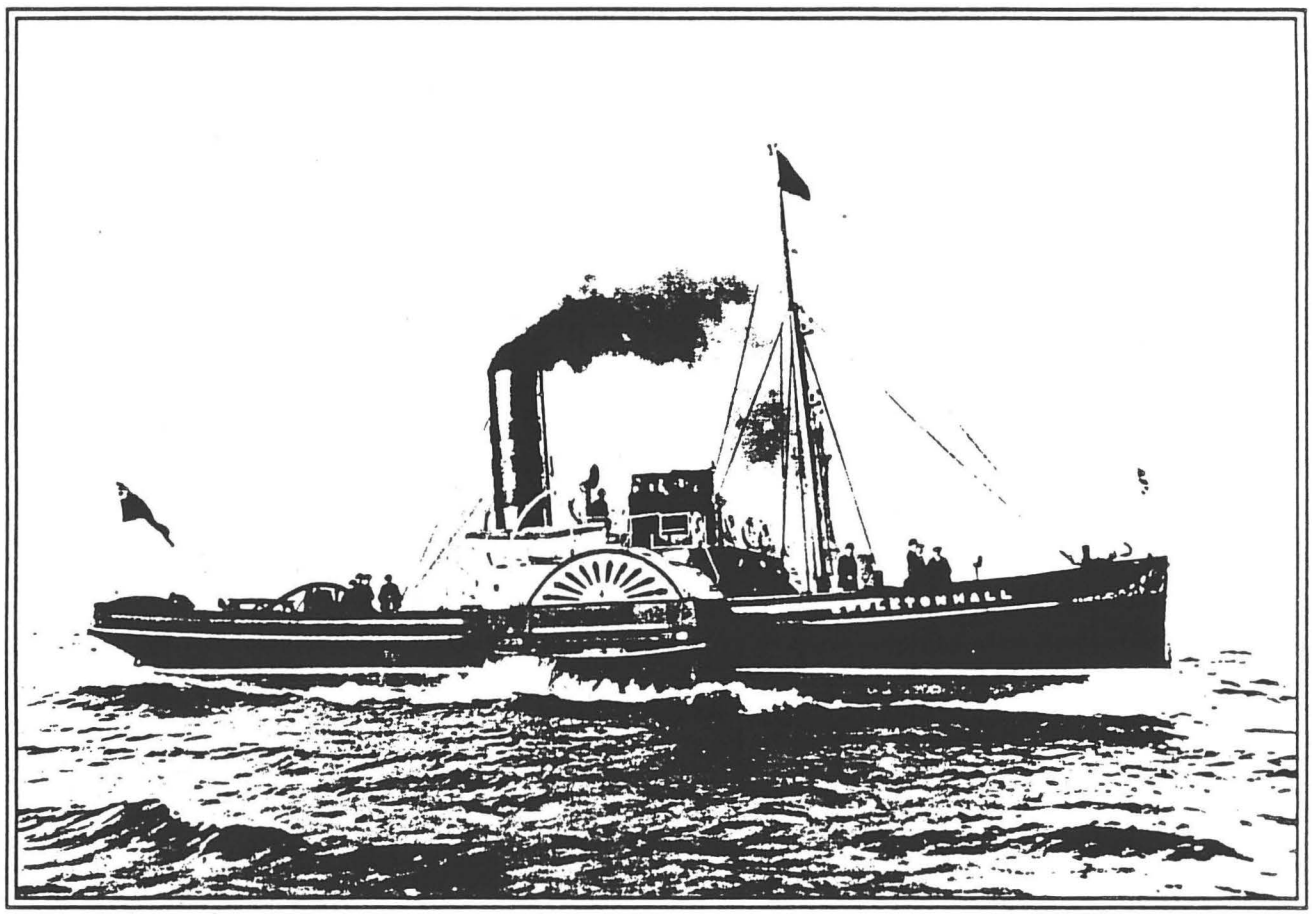
a.	Renew main deck stringer attachment and waterway	$ 450,000
b.	Renew 'tweendeck stringer attachment	$ 300,000
c.	Renew hold stringers	$ 100,000
d.	Renew 'tweendeck planking	$ 80,000
Total for Year #3		$ 930,000

FY 91: Non-essential Work

a.	3 lower topsails and 1 staysail	$ 18,000
b.	Sufficient running rigging for these 4 sails	$ 10,000
Total for Year #4		$ 28,000
Sub-total for 4-Year Program		$ 2,238,000
Specifications and engineering (at 8%)		$ 179,000
Total for 4-Year Program		**$ 2,417,000**

8. Reference

TCM survey and specifications, 1985



EPPLETON HALL on her sea trials, 1914

C. Steam Paddle Tug EPPLETON HALL

1. Particulars

Length molded:	100 ft. 6 in.	Depth molded:	10 ft. 10 in.
Beam molded:	21 ft. 1 in.	Gross tonnage:	166
Beam maximum:	33 ft. 3 in.	Net tonnage:	27

Built: Hepple & Co., South Shields, England, 1914, for Lambton Colliers, Ltd.

Hull: riveted steel Decks: wood Superstructure: steel and wood

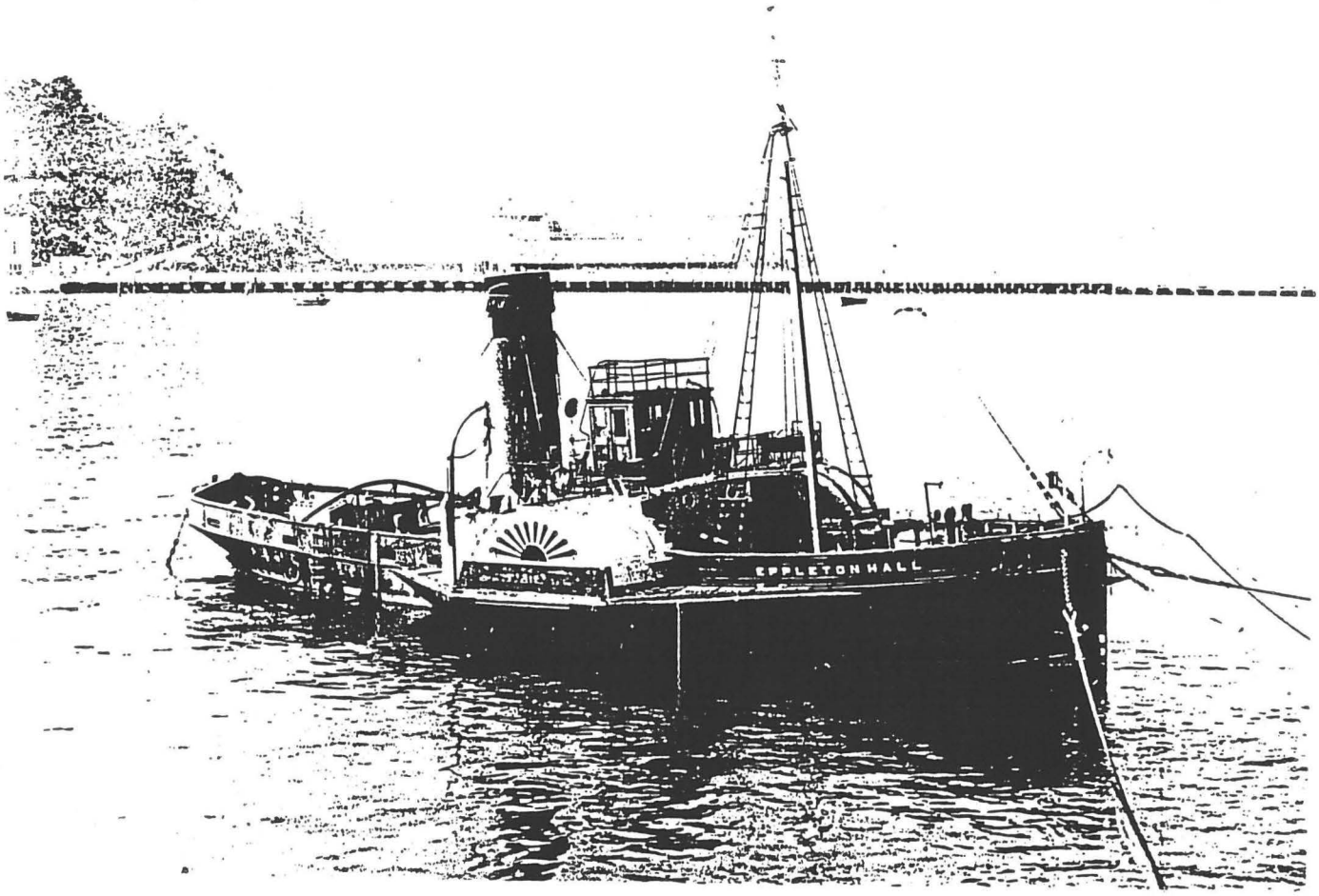
Machinery: Twin side lever ("Grasshopper") steam engines, 500 hp, turning two independent sidewheels
2 oil-fired boilers

2. History and Relevance

EPPLETON HALL was built in England in 1914 and served as a river and harbor tug there until her lay-up in 1968. Her relevance in the NPS historic fleet in San Francisco is therefore indirect. She is, however, representative of a type of steam propulsion which was once common on San Francisco Bay and its tributaries. She is a unique survivor, "one of the last intact sidewheel steam tugs, and the last tug with this type of engine" (Brouwer). The tug RELIANT, a near-sister to "EPPIE", is preserved in England, but in a much altered state. Such tugs made possible the development of engineless sailing cargo ships of the type represented in San Francisco by BALCLUTHA. Dual engine, twin paddle wheel tugs were first developed in England, on the river Tyne, and were so efficient and maneuverable that the design remained substantially unchanged from the 1850s to the time of EPPLETON HALL's construction. She is an excellent example of a long-lived and successful type.

3. Preservation History

The saving of EPPLETON HALL from a British scrap yard in 1969 is one of the great adventures of maritime preservation. The story is documented in the book The Eppleton Hall by Scott Newhall, the man who instigated and directed the project. It tells of her refurbishment and delivery under her own steam across 11,000 miles of deep sea from the River Tyne to San Francisco. When the vessel arrived in San Francisco in 1970, she was in operating condition, though in need of repairs and with a badly leaking deck. While she was never open to the public or interpreted as an exhibit, she was a lively presence on the Bay. Her enthusiastic crew of volunteers succeeded in maintaining her and steaming her on occasional excursions throughout the 1970's. This level of maintenance and activity has not been sustained in recent years; her last steaming was in 1979, and she has lay idle and largely unattended since that time.



EPPLETON HALL lies at her mooring in Aquatic Park, some twelve years after her arrival at San Francisco.

4. Recommended Use

Recommending a course of action for EPPLETON HALL's long term preservation is problematic. The value of the ship to the collection depends on whether the curatorial policy is firmly bound to seek local homogeneity, or can accept a larger and more eclectic view of ships as artifacts. Even if the decision is reached that the ship is not sufficiently relevant to the rest of the fleet, there is still a responsibility to recognize her historic significance as the last example of a technologically important type. Three alternatives have been considered.

a. Restore to operational condition

The best possible end use would be to again restore the vessel to steaming condition, and operate her on a limited basis. This will be a far more ambitious undertaking than the 1969 restoration, which started with a burnt out hulk. This time extensive removals must precede the work, as the boilers are in need of extensive rebuilding, and some shell renewal will be needed.

Due to the needs of the rest of the fleet, such a project will be a very low priority for federal funding. It may be possible to have the ship restored by a joint venture with a private organization. Worth exploring, for example, is the possibility of seeking sponsorship for the vessel from a U.K. based company with a strong business commitment to San Francisco.

b. Development of the vessel as a stationary museum ship

The next best option would be to restore the vessel as a museum ship with public access. It would be a simple matter to provide an on-deck-only tour of the vessel, but this would offer the public only a limited view of her boilers and machinery, which are the most important and interesting part of the ship. Getting visitors below could be done, provided some compromises were made in the structure.

Both boilers are in need of rebuilding, and the port boiler appears to be in the worst condition. Consideration should be given to the following:

1. Sacrifice the port boiler by cutting through it longitudinally to expose the interior construction. EPPIE's boilers are a fascinating example of hand forged craftsmanship, and, although built in 1946, are important examples of a 19th century technology which has rarely been interpreted elsewhere.

2. Scrap out all of the fuel oil tanks, at least on the port side. Most of these were installed for her trans-atlantic voyage, and are not considered important fabric. This will open a passageway alongside the engines.

3. Cut a passage through the aft accommodation bulkhead into the captain's cabin, and another through the forward bulkhead into the forward crew accommodations. It will then be possible to have a public tour descend into the after accommodation, pass alongside the bisected and interpreted boiler, past the engines, and exit back to the deck via the forward accommodations.

4. Run the main engines on live steam, either from a restored starboard boiler working at low pressure, or from a donkey boiler or steam generator located off of the ship. This latter option is probably the safest and least expensive.

5. The above program will forego steaming the vessel on the Bay; even if the starboard boiler were operable, the vessel may not be able to stem the tides on such reduced power. Obviously, this approach will also sacrifice some structural integrity.

   In exchange for these compromises, EPPLETON HALL can be developed as one of the best exhibits of steam propulsion to be seen anywhere. She would become accessible to the public at large, rather than to the tiny numbers of guests she would carry on limited excursions as an operational vessel. The integrity of outward appearance and setting would be retained.

c. Stabilization and maintenance only

This is the minimum level of effort that can be considered responsible treatment of an historic ship. Recommendations to achieve a stabilized status have been submitted with the survey report, and are reproduced here in Item 6, "Recommended Steps".

5. Existing Condition

a. Summary

EPPLETON HALL was surveyed while afloat at her mooring in Aquatic Park in January of 1987. recommendations for stabilization and a draft report of the survey were submitted soon after. Her last out-of-water inspection was performed during drydocking in 1983.

The vessel's overall condition has deteriorated to the point where a restoration as extensive as that carried out in 1969 would be needed to return her to the condition she was in at the time of her arrival in San Francisco. Recent efforts to stabilize the vessel have slowed the rate of deterioration, but not arrested it. EPPLETON HALL is not in danger of becoming a total loss in the near future, yet the cumulative effects from lack of maintenance have rendered her more difficult to preserve.

b. Hull

The hull is riveted steel with a single deck, which is steel over the boilers, and wood fore and aft. The bulwarks are wood forward of the paddleboxes, and steel aft. The sponsons, paddleboxes and paddlewheels are composite wood and steel construction.

The exterior shell was sandblasted and painted during the 1983 drydocking. The condition of the hull coating is fair above the waterline, but unknown below. Comparison of 1987 internal ultrasonic gaugings with those of the 1983 survey do not show any significant increase in wastage of shell plating, but 13% of the 1987 gaugings were under .200 of an inch. This is considered a marginal thickness and represent a potential threat to watertight integrity. Thin areas of shell plating should be addressed at the next drydocking.

The interior shell condition varies greatly. The hull in the area of the accommodations is entirely sheathed with wood. Partial removal of the sheathing revealed that the shell has been coated with a soft film preservative, which has largely retained its effectiveness. The shell in other areas, including the chainlocker, bilges, and side shell in the machinery space, is suffering heavy and ongoing corrosion. The worst area is in the engine room, where the placement of the fuel tanks makes it virtually impossible to adequately maintain the hull, or the tanks.

c. Decks and Superstructure

The wooden decks have leaked badly ever since the initial restoration in 1969. The forward deck can be stabilized in the short term, but requires such extensive repair that renewal is considered the best long term option. The aft deck is still salvageable. Renewal of decks should be closely coordinated with other restoration work, such as removal of fuel tanks, and other tasks which can only be accomplished with deck removed.

The wood bulwarks are partially rotten and would best be renewed in conjunction with deck renewals. The bridge deck and pilot house are repairable, but the sponsons and paddleboxes are mostly rotten and require major renewal of wooden members. The steel fidley is in fair condition, but the stack is in need of extensive repair due to wastage along riveted seams.

d. Machinery and Equipment

The vessel last steamed in 1979 and the machinery has not been regularly maintained since that time. As a result, the exterior surfaces of the engines are beginning to rust. The engines appear intact and complete, but true condition cannot be determined without partial disassembly for internal inspection.

The boilers were inspected in 1983 by Hartford Steam Boiler Co., and considered condemned unless major repairs were undertaken. The extent of the needed repairs and costs were not determined at that time.

Some of the auxiliary pumps and piping are either missing or disassembled. All twelve of the non-integral fuel, lube oil, and water tanks are heavily corroded and covered with rust scale. All valves and sounding pipe plugs are frozen, at least for hand operation. The contents and internal condition of the tanks have not been determined.

The anchor windlass is intact, but its steam engine is partially disassembled and corroding. The steering gear is intact, but shows such excessive wear and play that it should not be relied upon for operation.

The paddlewheels were sandblasted and painted in 1983 and the paddle boards were renewed. The paddle frames and feathering mechanism are steel and intact, although a substantial amount of material has been lost to corrosion over the years. Recent collision damage to the port sponson may have affected the alignment of the shaft.

The tubular steel mast is in fair condition, but the shrouds are heavily corroded and the ratlines are rotten and unsafe.

6. Recommended Steps

a. Recommendations for Stabilization

In view of the overall funding needs of the fleet, a full restoration of EPPLETON HALL will probably not be a priority in the near future. The following immediate steps, however, are recommended to minimize further deterioration of the vessel:

1) Keep boilers empty, and all ports open for ventilation. A heat lamp sufficient to maintain the internal temperature one or two degrees above the external temperature will help to prevent condensation. The boilers were found more than half full of water with the top inspection plates open. The free movement of aerated water is extremely conducive to corrosion.

2) Place a small capacity stripper pump in the engine room and keep limbers clear. Numerous leaks in the fidley and stack areas allow rainwater into the engine room. Every roll of the ship causes the bilge water to surge across her flat bottom, and the rapid movement of this highly aerated water duplicates a wind-and-waterline condition in the bilge, which again is extremely conducive to corrosion.

3) Stop leaks into the engine room from the fidley and stack. The steel skylights on the bridge deck level are dished below the plate level and rusted through. A plywood cover sealed with roof cement would be the fastest and least expensive remedy. Numerous areas of the stack are rusted through, and could be superficially patched with sheet metal secured with self-tapping screws and bedded in a flashing compound. The manhole plates in the boiler casing abaft the stack are not watertight, and should be sealed with a silicon caulk or equivalent.

4) Coat the external surfaces of all machinery with fluid film preservative, and lubricate all accessible internal works. Ultimately, the cylinder heads should be opened and the cylinders flushed with oil. The main engines are the most valuable part of the ship and the most expensive to repair. At this point, a thorough inspection will require at least partial disassembly, followed by reassembly with liberal use of preservatives throughout. This work has been estimated by Mr. Harry Morgan to require four hands for about two weeks, and does not address remedy of major defects discovered in the process. Until a greater level of effort can be funded, external coating will be helpful.

5) The scupper pipes midships, on both port and starboard sides, are rusted through, allowing water to drain into the engine room bilge. This can be temporarily repaired by cutting out the pipe and replacing it with a section of hose secured by clamps.

6) A small cover or awning should be erected fore and aft on the main deck, over the skylights and companionways. This will permit them to remain open for ventilation while keeping the rain out.

7) The windlass should be coated with fluid preservative and fitted with a canvas cover. The steam engine is partially disassembled and is likely to be suffering from internal corrosion.

8) All exterior woodwork should be preserved; the teak should be oiled, and all other wood treated with wood preservative.

9) Deck seams should be bumped down and repitched. This treatment will not be effective in areas that are already rotten. In these locations, principally to starboard of the windlass, and across the forward butts of the after deck, the deck may be rendered watertight by covering with wood or metal patches bedded in flashing cement.

10) To reduce wear on pintles and gudgeons, the rudder should be secured by means of turnbuckles between the bulwark pad eyes, or swing stops, and the tiller bar.

11) The pilot house roof is rotten in places and leaking freely. Vertical joints between panels are open. Ideally, the whole house needs to be covered, but at a minimum the roof should be sealed, or covered with plastic, plywood, or canvas.

12) The paddle boxes are in need of renewal, but for the short term it would help to fill all joints and voids with a soft seam compound and paint over them. Screening should be put on the interior to keep the pigeons out. To be most effective, this will include partial disassembly of the paddle wheels, as the immersed portions are corroding and otherwise unmaintainable. Storage of the pieces under cover is preferable to ongoing deterioration, but disassembly should only be undertaken if resources are available to thoroughly document the assembly, indelibly mark the pieces, and secure them in a protected area.

13) Plug all overboard discharges except scuppers.

14) Have a diver inspect zincs and bottom coatings.

15) Remove the rotten davit tackles before someone is tempted to use them.

16) Install fire and bilge alarms. Due to their small size, limited freeboard, and great weight of machinery, tugs have very little reserve buoyancy; even a small leak can rapidly sink one.

17) Shift her moorings to orient her with the prevailing westerly winds and swell.

b. A Phased Plan for Restoration and Operation of EPPLETON HALL

Should the decision be made to return EPPLETON HALL to operational status, the work could be done in a fashion similar to the 1969 restoration, that is, an intense start-to-finish period in a commercial shipyard. If this were the case, the scheduling and sequencing of work would depend on the shipyard involved, and would be determined by their facilities and workload, as well as by the availability of funding.

A more likely scenario would be a phased restoration over a number of years, utilizing volunteers and a variety of contractors. The sequencing for such an approach is outlined in the following phased plan; the time span has been condensed to fit the 4-year program for the fleet overall, but may be expanded without affecting the sequencing.

FY 88: Phase I

The priority in Phase I is on planning and preparation, creating the conditions under which work can begin.

1) Carry out stabilization measures outlined above.
2) Plan the restoration; drawings and specifications will need to be developed, costs and funding determined, and division of responsibilities between NPS and volunteer or private organizations established.
3) Re-moor the vessel with a floating pier, and new brow; this will improve access and stability, and possibly allow limited onboard interpretation and public tours.

FY 89: Phase II

The priority in Phase II is on getting up steam. Steam will return life to the ship, and will again draw supporters to her. The machinery is the most important part of her, and where most of the money and effort will go. Completion of this phase will permit dock trials.

1) Clean and coat hull and bulkheads in engine/boiler room.
2) Rebuild boilers.
3) Repair fuel system.
4) Overhaul main engines.
5) Rebuild auxiliaries.
6) Renew steel deck over boilers; removal of this structure will most likely be required to accomplish boiler rebuilding.

FY 90: Phase III

The priority in this phase is getting underway as soon as safely possible. Drydocking will be required.

1) Renew approximately 15% of shell plating.
2) Repair wasted areas of stack.
3) Overhaul paddle wheels.
4) Rebuild paddle boxes.
5) Overhaul and repair steering gear and windlass.
6) Install safety equipment, life rafts, radio, etc.

FY 91: Phases IV, V, and VI

The subsequent phases will complete the rebuilding to a maintainable condition.

Phase IV

1) Remove forward bulwarks, foredeck, mast, interior joinerwork, and all old fuel tanks in engine room and under galley sole.
2) Scale and coat steel deck structure and interior of shell.
3) Re-install necessary tankage.
4) Renew foredeck, bulwarks; replace deck furniture and interior joinerwork.

Phase V

1) Make minor repairs to fidley.
2) Repair pilot house and bridge deck.
3) Repair steel bulwarks aft.
4) Remove aft deck, deck furniture, and interior joinerwork.
5) Scale and coat steel deck structure and interior of shell.
6) Renew aft deck, replace deck furniture and interior joinerwork.

Phase VI

1) Restore boats and davits.
2) Re-rig mast.
3) Install awnings and stanchions.
4) Misc. outfitting.
5) Interpretation.

This sequencing is not particularly logical from a technical standpoint. It would be far more efficient to gut the ship, carry out all shell renewals, as well as scaling and coatings, before replacing repaired machinery and renewing woodwork. However, such an approach only works if sufficient funding is available from start-to-finish.

The sequence outlined above places priority on getting steam up to attract support, and phasing other repairs so the ship is not completely torn up at any one time. This is more likely

to be the logical approach for accommodating start-stop cycles, while keeping the interest and participation of volunteers.

Should the "stationary museum ship" option be pursued, with public access to the engine and boiler room, the sequence would be altered. The foredeck removals may come first to permit removals of tanks, to be followed by shell repair and coatings work while the hull was open. The boiler cut-away would best be done by removing the plated deck above, and taking the port boiler out of the ship. This could make possible a clean enough cutting job to retain both halves of the boiler, one for reinstallation in the ship, and one for exhibit elsewhere. The rest of the work would be roughly as outlined above. By placing emphasis on the removals, public access could be gained while work was in progress on machinery or other parts of the ship.

Even if EPPLETON HALL is not to be restored or developed as part of the Museum, the only responsible course of action is to carry out all stabilization measures as promptly as possible. On an international level, the ship has a real historic validity and should be kept intact until an appropriate institution can be found to accept custody or ownership of the vessel.

7. Table of Cost Projections, EPPLETON HALL

FY 88: Phase I

1)	Stabilization measures.	$ 20,000
2)	Planning, drawings, specifications.	$ 40,000
3)	New mooring, float and brow.	$ 35,000
Total for Year #1		**$ 95,000**

FY 89: Phase II

1)	Clean and coat eng./boiler room.	$ 40,000
2)	Rebuild boilers.	$ 300,000
3)	Repair fuel system.	$ 10,000
4)	Overhaul main engines.	$ 60,000
5)	Rebuild auxiliaries.	$ 15,000
6)	Renew steel deck.	$ 50,000
Total for Year #2		**$ 475,000**

FY 90: Phase III

1)	Renew portions of shell.	$ 60,000
2)	Repair stack.	$ 15,000
3)	Overhaul paddle wheels.	$ 20,000
4)	Rebuild paddle boxes and sponsons.	$ 80,000
5)	Repair steering gear and windlass.	$ 20,000
6)	Safety equipment.	$ 20,000
Total for Year #3		**$ 215,000**

FY 91: Phases IV, V, and VI

Phase IV

1)	Remove foredeck, joinerwork, tanks forward.	$ 15,000
2)	Scale and coat decks, shell.	$ 20,000
3)	Re-install necessary tankage.	$ 10,000
4)	Renew foredeck, joinerwork.	$ 60,000
Sub-total		$ 105,000

Phase V	
1) Repair fidley.	$ 3,000
2) Repair pilot house and bridge deck.	$ 15,000
3) Repair aft bulwarks.	$ 10,000
4) Remove aft deck and joinerwork.	$ 10,000
5) Scale and coat decks, shell.	$ 20,000
6) Renew aft deck and joinerwork.	$ 50,000
Sub-total	$ 108,000
Phase VI	
1) Restore boats and davits.	$ 10,000
2) Rerig mast.	$ 15,000
3) Awnings and stanchions.	$ 20,000
4) Miscellaneous fittings.	$ 10,000
5) Interpretation.	$ 30,000
Sub-total	$ 85,000
Total for Year #4	**$ 298,000**
Total Project Cost	$ 1,083,000

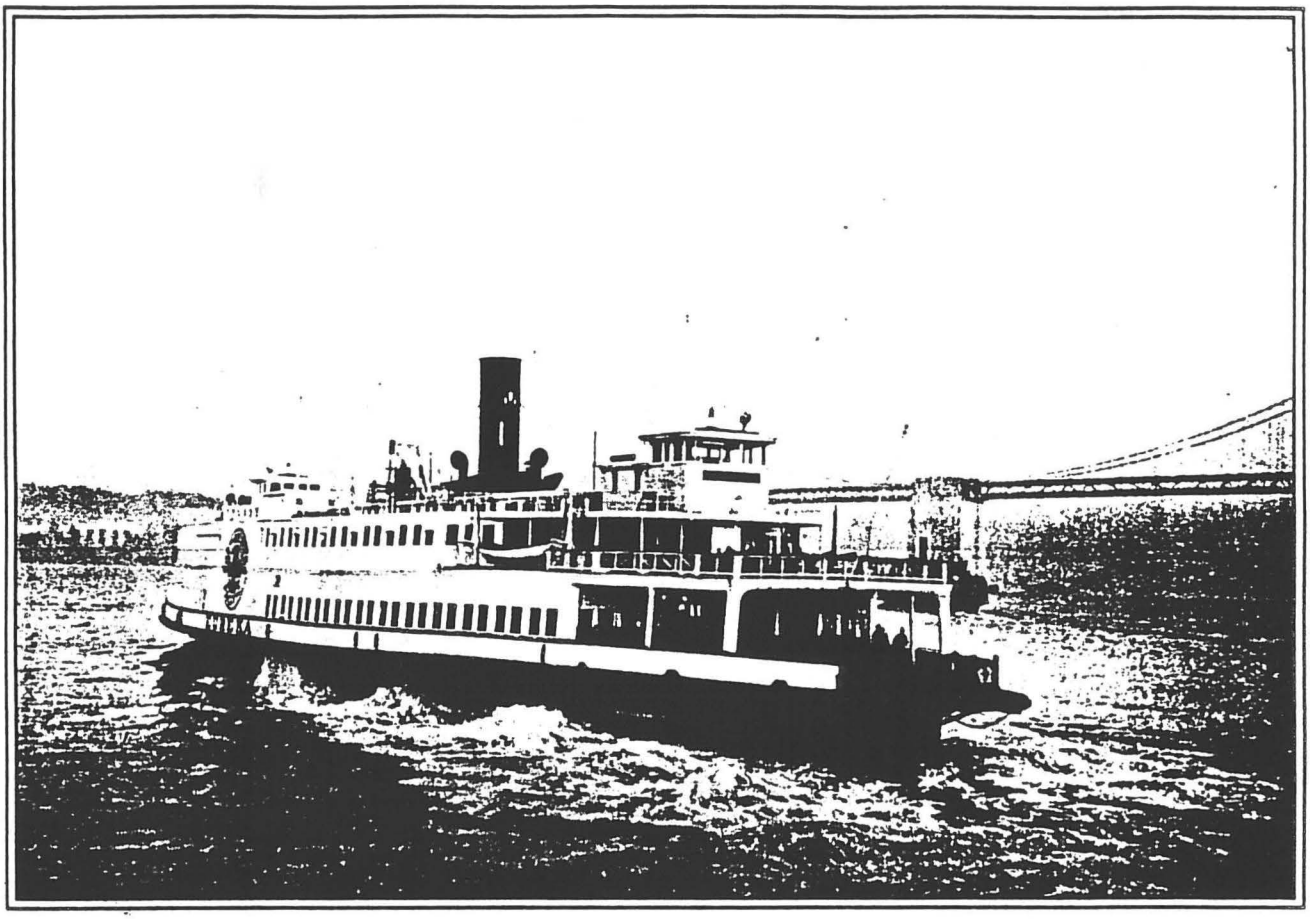
Note: An organized volunteer effort can significantly reduce the total project cost. A reasonable estimate of the maximum savings possible is about 25% of the total, or $ 270,000.

8. References

Hull and Cargo Survey and Secifications, 1982

Hartford Steam Boiler Inspection Report 1983

Tri-Coastal Marine Survey Report 1987



EUREKA leaving the Ferry Building, 1941

D. The Ferry EUREKA

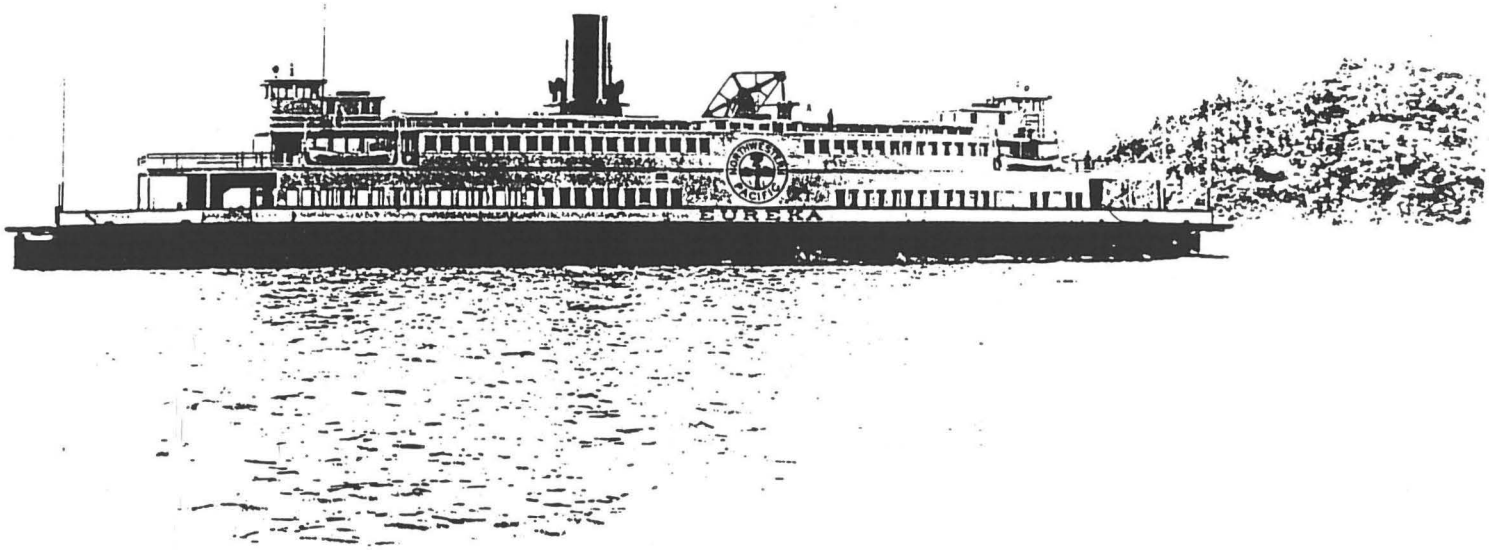
1. Particulars:

Length between perpeniculars:	276 ft. 4 in.	Draft:	8 ft. 3 in.
Length overall:	299 ft. 6 in.	Beam molded:	42 ft 8 in.
Gross tonnage:	2564	Beam Maximum:	78 ft. 0 in.
Net tonnage:	2018	Depth molded:	15 ft. 8 in.

Built: in Tiburon, California, 1890, for San Francisco and North Pacific Railroad

Hull, decks and superstructure: wood

Machinery: sidewheel, walking-beam steam engine, single cylinder, 65 inch bore, 144 inch stroke, 1500 hp.



EUREKA on the Marin County ferry run.

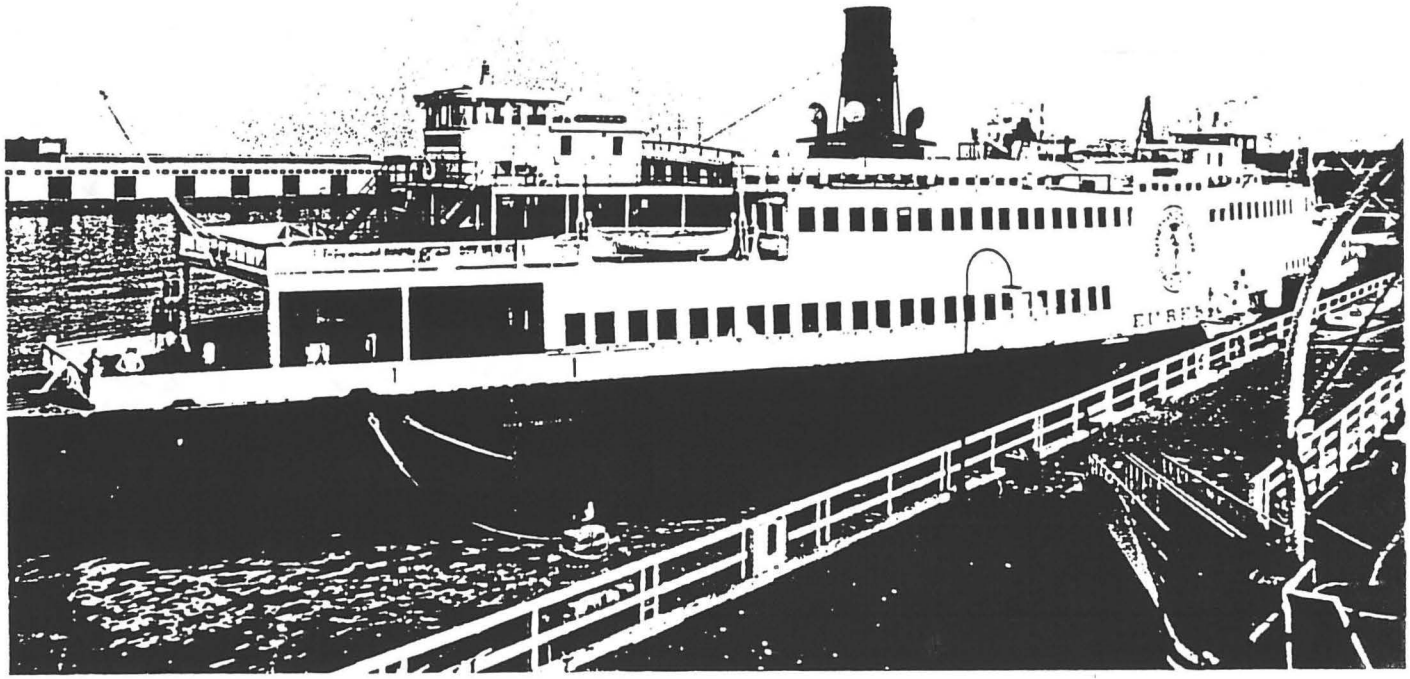
2. History and Relevance

EUREKA was built in Tiburon in 1890 as UKIAH, a train ferry used to shuttle rail cars across San Francisco Bay for the North Pacific Railroad. In 1920, as the weight of passenger traffic shifted from rail to auto, the vessel was substantially rebuilt as a passenger and automobile ferry, and renamed EUREKA. Until her retirement in 1957, she plied various ferry routes around the Bay, rounding off a remarkable 67 years of service.

EUREKA was the last walking-beam sidewheel ferry to operate in North America, and remains one of the largest floating wooden structures in the world. Her engine is a massive example of a basic design first developed in the 1820's, and hardly improved upon through a century of steam navigation. Many Bay Area commuters still remember the stately rock of EUREKA's walking beam as an everyday sight.

3. Preservation History

Steam passenger ferry service on San Francisco Bay was ending as the State of California assembled its historic fleet of ships. EUREKA is one of the few ships to pass from active service directly to museum status without an extended period of idle decay. With a collection of period autos on her car deck, passenger spaces cleanly painted and dressed, and a newsstand with period publications and artifacts on display, she has been an effective exhibit. Perhaps most impressive is her massive engine room machinery, which is shown by guided tours. The engine can be rotated by an electric motor to interpret its workings to the public. Part of her car deck has served the museum staff variously, as shipwrights', rigging, and boat building shops, and one of her pilot houses serves as office space.



EUREKA on exhibit at Hyde St. Pier

4. Recommended Use

EUREKA is best suited to continue in her role as a stationary museum ship. Ideally she will remain at her present location, a slip similar to those she steamed from while in service. This does not preclude a limited degree of operation. A study is recommended to determine the feasibility of activating one of the four boilers to produce steam for operating the main and auxiliary machinery. This would have great interpretive value; there is nothing like live steam on a vessel to draw a crowd together, both of visitors and volunteers. The increased volunteer interest could be expected to benefit the preservation of the machinery, if not the entire vessel.

Having live steam on the vessel will, however, carry an increased risk of fire. Any plan to carry fuel on board, or to fire up a boiler, should include installation of a fire suppression system. A more conservative program, though less attractive from an interpretive standpoint, would be to provide steam from a shore side steam generating plant.

5. Existing Condition

a. Summary

Although EUREKA is presently open to the public, and a successful exhibit, she is nearing the point where further deferral of major preservation work will have irreversible effects. When donated to the State in the late 1950's, her hull was in good condition, largely because of an extensive rebuild in 1953. The hull has deteriorated quite slowly since that time, due mostly to the protective effects of the large overhanging superstructure, or "house". The house has itself undergone several rebuilds since EUREKA become a museum ship; the relatively lightweight construction made the work straightforward. The hull, on the other hand, can only be repaired at great expense, and it is this work that the Museum now faces.

Nothing short of a major commitment to rebuilding and maintenance will insure the vessel's long-term existence as a museum ship. As one of the last and best examples of a steam paddle ferry, EUREKA is an invaluable artifact and worthy of the considerable effort this commitment demands.

b. Recent Work

In 1984, a comprehensive condition survey was made of the EUREKA, and the vessel underwent cyclical maintenance, for which she was drydocked. Work performed in the shipyard included renewal of some damaged plywood sheathing, recoating of bottom and topsides, and renewal of two short sections of the rub rails. In 1985, the much deteriorated aft end of the passenger deck was rebuilt with a combined effort of contractor and staff. Also in 1985, the worst deficiencies of the electrical system were repaired. In 1986, the staff completed a partial renewal of the starboard aft side of the house, and work is in progress on a comparable section on the port side. A largely volunteer effort has cleaned and painted the engine/boiler room and some of the machinery, resulting in a marked improvement in condition and appearance.

c. Condition

1) Hull

Overall, the hull is in fair condition. There are two major exceptions: rotten caulking throughout the bottom, and deterioration at the bow and stern.

The caulking was inspected during drydocking in 1984, and was found to be rotten in all twelve areas where sheathing was removed for inspection. This condition weakens the hull, and reduces watertight integrity.

During survey, major areas of rot were found in the forepeak and aftpeak involving frames, ceiling, deck beams and planking. The aftpeak is the worst area of deterioration. Both forepeak and aftpeak will require major rebuilding in order to prevent the further spread of dry rot.

Other structures where rot was found include a section of keelson directly under the walking beam, and numerous small areas in the floors, frames, keelsons and ceiling, at and below the turn-of-bilge.

Severe wastage of iron fastenings and hogging straps was seen at and below the turn-of-bilge, in all hull compartments. This is due to excessive bilge water, and the salt treatment used to prevent rot. Wastage of fastenings results in loss of holding strength, a serious problem which will have to be addressed in the long term.

The hull planking appears in good condition throughout, and most of the ceiling, framing, floors, and bulkheads are sound.

2) Main Deck

The main deck is in good condition inside the house, but in generally poor condition where exposed fore and aft. The entire deck structure over the forepeak and aftpeak is severely rotten and leaking. Another area of severe rot was found in deck beams and planking over Hold #6. All these areas are candidates for major structural renewals.

Other areas of rot were found in deck beams and planking, particularly in the engine room. Most of these areas can be treated with wood preservative, though some will eventually need to be repaired.

3) Sponson Deck (overhanging portion of main deck)

The rub-rail is rotten for almost the full length, port and starboard, and roughly 40% of the deck beams are rotten at the outer ends. Pigeons are nesting in the rub-rail, and the accumulation of their droppings is contributing to this rot. The beams will have to be sistered and the wasted rub-rail replaced. Both spring beams, the large timbers outboard of the paddle wheels, are severely wasted and must be replaced.

The deck beams and planking overhanging the fore and aft ends are extensively rotten and will have to be renewed, along with the forepeak and aftpeak.

Almost all of the diagonal sponson braces and hanging knees, though weathered, are sound. Most of the deck planking and inboard sections of deck beams are sound.

4) House

The aft end of the house has recently undergone a rebuilding, but the forward end still suffers from extensive rot, particularly on the port side. Interior and exterior sheathing, window sills and frames, cap rail, covering boards, and internal studs are rotten variously. Rainwater seepage, through the covering boards and mouldings, is the primary cause.

In the 1984 survey, rot was found in the bulwarks, passenger deck deck pillars, and stairwells fore and aft. The pillars at the aft end were renewed or repaired in 1985, but most of the other items remain in deteriorated condition.

5) Paddle Boxes - Port and Stbd

Both paddle wheels are weathered and the frames and fittings severely corroded. These should be scaled, treated and painted. Both paddle box bulkheads are rusted and should be sandblasted, or scaled and painted.

The riveted steel support beams at the ends of the shaft, port and starboard, are seriously wasted. The beam on the starboard side is in poor condition, with wastage estimated at 70%, while port side beam is in better shape, with wastage at about 30%. Both beams should be repaired, scaled or sandblasted, and painted.

The king posts appear in good shape, and the interior sheathing of the paddle boxes is weathered, but otherwise sound.

6) Passenger Deck

The aft end of the passenger deck underwent a major rebuild in 1985, and is presently in good condition. Renewed were pillars, stringers, beams, decking, and canvas. The forward end of the passenger deck has rot in numerous deck beams, davit foundation timbers and boat chocks, areas of deck planking, some deck stringers, and handrails. In addition, the pillars supporting the hurricane deck above are weakened by deterioration. This entire area will have to be rebuilt in the near future.

Within the House, including the rest rooms, rotten areas were seen in the interior tongue & groove sheathing, window sills and frames, panels and trim pieces, and internal studs. Several deck beam ends and sections of deck planking along the deck edge are also rotten. This rot reflects the deterioration, and resultant rainwater seepage, taking place in the exterior of the house. Repairs to these areas should be part of an overall rebuild of the port and starboard sides

of the House. In the mean time, all seepage should be arrested by temporary repairs to the hurricane deck above.

All other items on the passenger deck are in good condition.

7) Hurricane Deck, Dome Deck and Wheel Houses

With a few exceptions, the hurricane and dome decks, and the two wheel houses, are in good structural condition.

A series of deck beams at the forward end of the hurricane deck, port and starboard, are weak due to improper repair scarfs. In addition, there is localized rot in beams, and the support pillars are weakened. These conditions combined may eventually make this area of the deck unsafe under a load.

The roof of the men's head is rotten along the outboard edge. Some repairs have been made to this area, but a total rebuild is needed. The covering boards on the hurricane and dome decks are rotten in places, and there are minor areas of rot on both decks, and in the forward wheel house. The steel hand rails along the perimeter of the hurricane deck are unsafe due to wastage and rot.

The most immediate problem is rainwater seepage caused by rot in the covering boards and moldings along the deck edge, and by concaveties and leaks in the ARABOL deck covering. These areas should be temporarily patched to prevent further damage to the house and passenger deck below.

8) Engine Room Machinery, Boilers

The condition of the engine room machinery has improved dramatically with the recent volunteer effort. The main engine is being lubricated and jacked over on a regular basis, and auxiliary pumps and dynamos are undergoing overhaul. Much of the water, steam, and fuel oil piping remains inactive, and the numerous valves have not been serviced or inspected. The massive steel engine bed is severely corroded, and will require a major effort to scale and coat.

All four boilers remain inactive, but boiler #2 has been partially dismantled by volunteers, and is being inspected with an eye to possible operation.

9) Interior of Fidley and Machinery at Dome Deck Level

The highest priority here is the smoke stack, which is rusted through in two areas: just above the apron, and at the top of the super heater. These sections of the stack should be strengthened by adding angle bars and brackets. The two steel platforms, port and starboard of the walking beam assembly, are badly rusted and collapsing. These will require complete renewal.

The upper end of the A-frame, and the stack and its steel apron, are rusting in numerous spots and need sandblasting and coating.

A canvas seasonal cover has been rigged over the walking beam opening, and appears to be effective in keeping rain out of the engine room.

10) Electrical System

Several deficiencies were found in the electrical system, many the result of improper repairs or additions. Furthermore, the system uses some of the original wire, which does not meet modern standards. The overall condition of this wiring is not known. Considering the high risk of fire in a wooden vessel, this is considered to be a potentially dangerous situation.

6. Recommended Steps

The recommendations in this section are organized in four levels of priority, which correspond to the four-year fleet preservation program. The relative level of priority given to each item is based on several factors, including safety, rate of deterioration, and logical work sequencing. Until more detailed studies and assessments are made, many of these factors will remain variables, with the result that priorities may change.

Priority I

a. Stabilization Measures

The preservation needs of EUREKA are so extensive that, even with consistent funding, it will take an extended period of time to address them all. Yet many of these needs are immediate, and will multiply, or result in irreversible damage, if not met. The solution is to devote some effort to temporary measures which will stabilize rapidly deteriorating conditions. The following items are some of the steps which should be taken.

1) Rot Treatment

Most of the major problems found on EUREKA are due to rot. Controlling and preventing rot is by far the largest task in the preservation of EUREKA. Rot is already extensive, and indications are that it is advancing at a rapid rate in many areas. A comprehensive program of rot treatment should begin as soon as possible.

The goals of comprehensive rot treatment program would be:

- To prevent the spread of rot to sound, unaffected members.
- To stop the advance of rot in already affected members, in order to avoid further loss of strength. This is important if repairs are to be deferred for any length of time.
- To replace the present system of salting in the lower holds and bilges. Though effective in preventing rot, salting has done considerable damage to iron fastenings and other metal components.

The most effective rot treatment might well be that which is presently under experimental use on WAPAMA. The active ingredient, sodium borate, is a product of the U.S. Borax Company, which has partially funded the experiment. If this treatment proves successful on WAPAMA, it will be the best candidate for use on EUREKA.

Regardless of which treatment is used, effectiveness (particularly in replacing the salt treatment) should be monitored and assessed after one to two years before continuing on a permanent basis. In addition to this treatment, efforts should be made in the following areas:

- Saltwater hose down of the fore and aft ends of the main deck on a regular basis.
- Keep the bilges as dry as possible, in order to reduce the level of moisture in the holds.
- Increase ventilation in the hull interior.
- Seal off all areas were rainwater is seeping in.
- Use of pigeon prevention systems to keep birds from nesting in the paddle boxes, rub-rails, sponson braces, and along deck edges.

2) Stopping Leaks

Of the above rot arresting measures, stopping leaks will be the most effective. This would include sealing of all leaking decks and exposed surfaces of the house. On the hurricane and dome decks, tar paper and roofing cement can be used to patch leaks in the deck covering, and to seal rotten areas of the covering boards. The sides of the house will be difficult to seal without a rebuild, but some of the worst areas might be patched or covered with tarps. The main deck, which is extensively rotten and leaking at the ends of the vessels, can be temporarily sealed by removing the wood deck sheathing, laying down roofing material, "hot mopping" with tar, and re-installing the sheathing.

3) Determining Hull Loading

A major uncertainty about EUREKA is the amount of strain to which the hull is being subjected, and the degree to which the hull has weakened. The amount of strain can be determined by development of a "loading curve", a graphic representation of the ratio between weight and bouyancy in the hull. The degree of weakening is more difficult to assess. Some deteriorated portions of the structure, and the rotten caulking, are contributing factors; their effects can be seen in the hogging and sagging of the hull. Measuring this distortion, and monitoring the rate of change, can help to determine the degree of weakening.

The importance of all this lies in the irreversible nature of hull distortion. The amount of distortion already seen in EUREKA's hull is cause for concern. It may not be possible, or necessary, to undertake stabilization measures immediately, but this can only be determined by an engineering study. This study should be performed as soon as possible, and will require engineering work by a naval architect. The results produced will determine the necessity and nature of corrective measures.

b. Upgrade Electrical System

Deficiencies in the electrical system pose a potential threat to the vessel and the public. Upgrading the system to meet the appropriate codes is therefore recommended. Further investigation should first be made to assess the shortcomings of the present system, the cost of upgrading, and the effects an upgrade might have on the fabric and appearance of the vessel.

c. Rebuild forward end of Passenger Deck

Rebuilding the forward end of the passenger deck will be much the same as the work performed on the aft end of the deck in 1985-86. This work is considered important for reasons of safety. Although this area of the deck is not as deteriorated as the aft end was, the amount of weakening is not certain and a rebuild is considered prudent.

d. Rebuild Forepeak, Aftpeak, and End Decks

The ceiling and framing in the forepeak and aftpeak is decaying due to continuous leakage of fresh water through the rotten decking above. This leakage has also caused severe decay of the heavy beams which support the end decks. Evidence that the ends of the vessel are weakening can be seen in the progressive opening of seams and butts in these areas. If deterioration continues unabated for several more years, an exponential increase in scope and cost of repairs can be expected.

Rebuilding will be a major task, but can probably be done with the vessel afloat, if undertaken before deterioration spreads much further into the hull. The place to start would be the forward end. This will allow public access to continue uninterrupted while work is going on. The vessel can then be end-for-ended to allow rebuilding of the aftpeak.

If the rebuilding of these areas is to be deferred, stabilization measures should be taken. Measures would include rot treatment and sealing the leaking deck. This is considered a temporary stopgap, but would be preferable to the effects of unchecked deterioration.

e. End-for-End Vessel

EUREKA is weathering unevenly due to prevailing wind, spray, and direction of the sun. The evidence for this is the marked difference between the deterioration of the port and starboard sides, and fore and aft ends. The vessel would benefit from the more even weathering which can be achieved by end-for-ending, or turning her around in the berth, on a regular basis.

The steps for achieving end-for-ending are:

1) Addition of a mooring chock and attachment point in the forepeak, as presently exists in the aftpeak.
2) Addition of connections, for the shore-side electrical, water, telephone, and fire alarm, on the starboard forward end, as presently exists on the port after end.
3) Re-routing of the sewer out-flow lines.
4) Moving the gangway plate and roller to the forward end.

In addition, it is recommended that a rebuild of the forward end of the sponson deck, forepeak, and rub-rail be undertaken prior to end-for-ending, at least in those areas that will bear on the dolphins.

Priority II.

f. Re-caulk and Re-copper Hull

During the 1984 drydocking, small portions of the plywood sheathing and copper were removed from various locations on the bottom, for inspection of planking. Less than 3% of the planking was inspected but the results were fairly uniform:

- The planking is still sound, with some scattered damage caused by marine borers.
- The caulking is waterlogged, mushy, and no longer effective in stiffening the hull, although it is still keeping the ship afloat.

- The felt sheathing and the copper sheathing are wasted through and no longer an effective barrier to marine borers.
- The plywood sheathing, put on as a temporary measure at an earlier docking when limited funding precluded recoppering, is delaminating at some edges.

The conclusion reached was that while the plywood has been reasonably effective to date in keeping marine borers out, it is not considered a long term solution. The soft caulking is a serious problem because the longitudinal stiffness of the hull is to a large extent dependent upon tight caulking. If this situation is not remedied, irreversible distortion of the hull may continue at an accelerating rate. The following is therefore recommended:

1) Removal all existing plywood and copper sheathing.
2) Replace damaged planking and refasten as needed.
3) reef out and caulk entire bottom of hull.
4) Renew copper sheathing

An alternative might be found for item #4, renew copper sheathing. One such alternative worth consideration would be a modified version of the plywood sheathing presently used. The process would involve lamination of thinner plywood sheets with epoxy, thus increasing resistance to worm damage. The advantage to such an alternative would be in terms of cost, and in avoiding the corrosive effect that copper sheathing would have on the hull's iron fastenings.

Priority III.

g. Renew Main Deck over Hold #6

The main deck is severely rotten and weakened over hold #6. This condition could become a safety hazard if allowed to spread much further. The area could be temporarily stabilized, but renewal is recommended. Work will be complicated because the passenger deck stairwell is located directly above. Ideally, this job would be scheduled after end-for-ending the vessel, so as to avoid blocking public access to the passenger deck on the onshore end.

h. Repair sponson deck and rub-rails

The sponson deck, deck beams, and rub-rail, are rotten around most of the perimeter of the ship. This is of concern because the structure supports much of the weight of the house. The noticeable sagging and distortion of portions of the house sides will accelerate as the sponson decks deteriorate further. Repair of the sponson deck should be carried out in phases, with the portions at the ends of the vessel being rebuilt along with renewal of the forepeak and aftpeak.

Rebuilding of the mid-length sections of the sponson deck should include renewal of the large timber spring-beams in way of the paddle boxes. The steel beams supporting the ends of the shaft should also be repaired or preserved during this phase of work.

i. Rebuild sides of House

The port side of the house, from the paddle box forward, is severely rotten and in need of major renewal. The starboard side is in better condition, being on the lee side. Keeping the sides of the house rain-tight is essential in preventing the further advance of decay in the sponson deck, and hull.

Priority IV.

j. Drydock for installation of buoyancy chambers/ballast

The need for additional buoyancy or ballast has not been definitely established and will depend on the results of a hull loading study. If determined to be necessary, buoyancy may be increased by addition of floatation tanks under the ends of the hull. Ballast would most likely take the form of water stored in ballast tanks in holds #2, #3, #5, and #6. Drydocking would be required for addition of buoyancy tanks. Other measures might include filling of existing fuel and water tanks, and removal of one or more of the rudders in order to reduce weight at the ends of the vessel.

k. Overhaul machinery

Much of the work of restoring and maintaining the machinery can be handled by the volunteer force. Some expense will nevertheless be incurred, particularly if the decision is made to activate one or more of the boilers.

l. Scale and Coat Engine Bed and other Steel Structures.

Many of the steel components on the vessel are in need of sandblasting, or scaling, and coating. Some will require repairs. The highest priorities are the stack, and the bearing beams outboard of the paddle wheels; these are exposed and wasting away at a rapid rate. Both will require repairs as well as preparation and coating.

The next priority is the engine bed, a large riveted structure which is entirely covered with heavy rust scale. The real problem here is the adverse effect the corrosion is having on the wood structure below. Preparation and coating will be very difficult due to the numerous, and almost inaccessible internal void spaces within the engine bed. Sandblasting is not recommended here, but waterblasting might be considered. The alternative to this would be manual scaling.

Other steel items needing attention are the paddle box and engine room bulkheads, steel support pillars in the engine room and on the main deck, and steel plates reinforcing wood knees.

m. Preserve Paddle Wheels

The paddle wheels will require both wood and steel preservation, and many of the components will need to be replaced or repaired. It is essential to continue periodic rotation of the paddles wheels in order to distribute the effects of saltwater immersion. The addition of zinc anodes to the steel framework is recommended.

o. Additional Recommendation

1) Bilge and Fire System

The existing bilge pumping system, though adequate for routine and emergency pumping in the engine room, is presently not capable of pumping the bilges in the other six compartments of the hull. This capability is desirable for two reasons: one, for emergency pumping in other compartments, and two, for making routine pumping more convenient. Portable pumps are presently required for both of these functions. Consideration should be given to the following:

An emergency bilge pumping system should be designed and installed. This system would utilize the existing large bilge pump, and would allow pumping of all compartments, with possible exception of the forepeak and aftpeak. The most economical and maintenance-free method would be to replace the existing wasted iron piping with a system using plastic (ABS) pipe. All wasted iron piping should be documented and removed from the bilge.

Small electric bilge pumps, of the type used in yachts and small commercial craft, should be installed in each of the seven compartments. These would be fitted with float switches and would automatically keep the level of water in the bilges as low as possible. This is important in reducing the level of moisture, and therefore, the rate of rot and deterioration in the lower Hull. The outflow from these pumps could be fed back to a central reservoir, where it would then be pumped overboard using the large bilge pump.

A program should be developed for maintaining and operating the bilge and fire system. This program would include:

- inspecting all bilge suction strainers for clogging, rotating all valves, and running all pumps once a month.

- staging regular fire drills using the ship's fire system. Two or three of the ship's fire stations could be tested during each drill, on a rotational basis.
- keeping a log of all maintenance and drills.

In addition to the above, the installation of a fire detection and alarm system should be considered. This system could also be integrated with a bilge alarm.

2) Maintenance

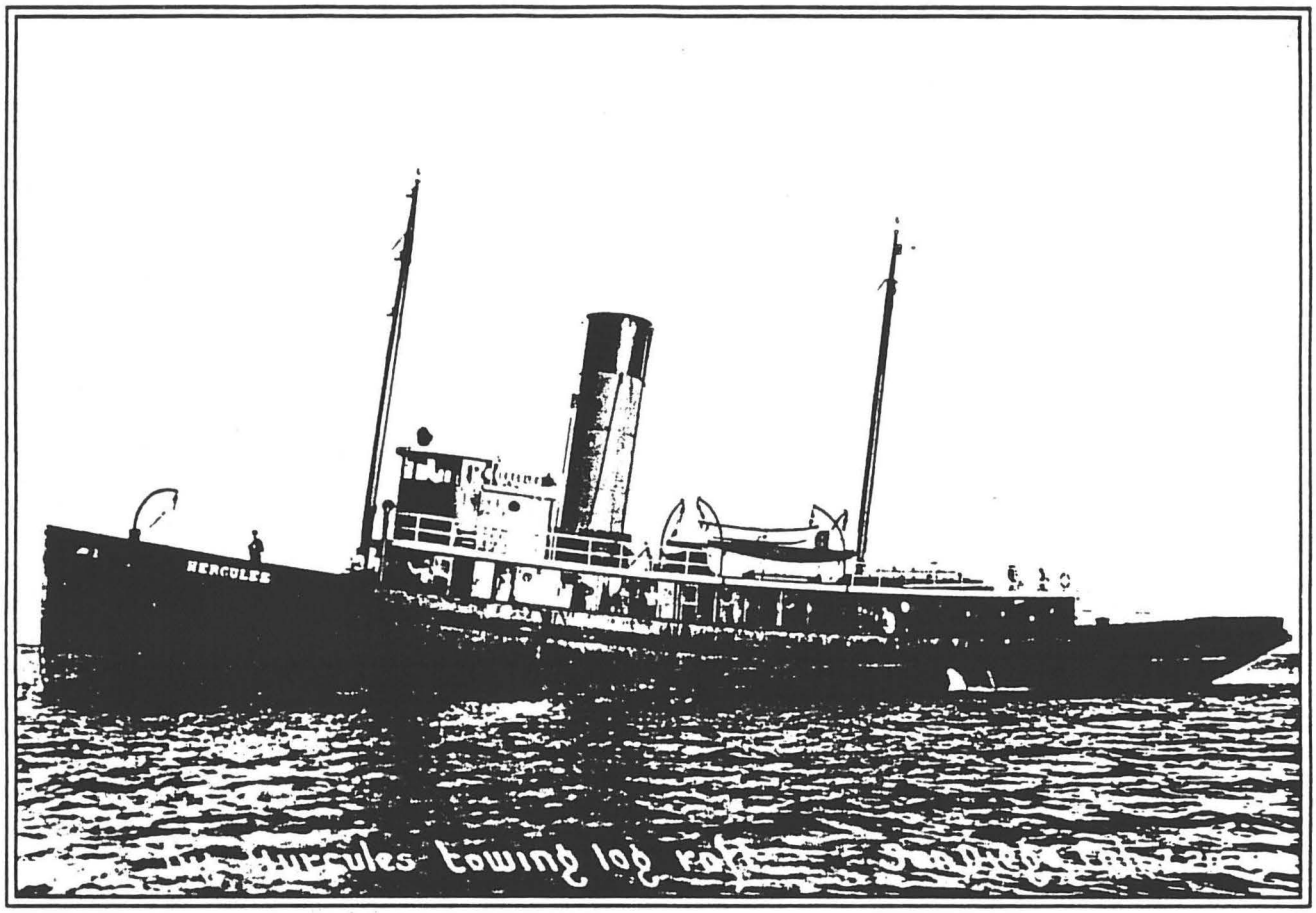
The problem of maintenance must also be addressed. By her nature, EUREKA requires a relatively high level of maintenance, a level which she has not received for some time. Almost all of the present deficiencies in her condition could have been prevented if an adequate crew had been on hand.

It is recommended that a comprehensive maintenance program be developed, and sufficient crew, supplemented by a volunteer work force, be assigned to EUREKA. This would be extremely cost effective, as the cost for major repairs far outweighs the cost of an adequate crew.

7. Cost Projection, EUREKA:

FY 88: Priority 1	
1) Stabilization measures: seal leaking decks, rot treatment, hull loading calculations.	$ 75,000
2) Inspect and repair electrical system.	$ 60,000
3) Rebuild forward end of passenger deck.	$ 180,000
4) Rebuild forepeak and forward end of sponson deck.	$ 240,000
5) Renew forward end of rub-rail.	$ 225,000
6) End-for-end vessel.	$ 25,000
Total for Year #1	**$ 805,000**
FY 89: Priority 2	
1) Caulk and copper the underwater hull.	$ 1,200,000
Total for Year #2	**$ 1,200,000**
FY 90: Priority 3	
1) Rebuild aftpeak and aft end of sponson deck.	$ 330,000
2) Renew section of rotten main deck above Hold #6.	$ 75,000
3) Renew remainder of rub-rail, spring beams, beam ends, repair bearing beams.	$ 590,000
4) Rebuild port side of house.	$ 240,000
5) Rebuild starboard side of house.	$ 160,000
Total for Year #3	**$ 1,395,000**
FY 91: Priority 4	
1) Install buoyancy chambers and ballast.	$ 200,000
2) Overhaul machinery.	$ 120,000
3) Scale and coat engine bed, bulkheads, other steel.	$ 160,000
4) Preserve paddle wheels.	$ 80,000
5) Remainder of necessary repairs, additional systems, and preventative measures (see EUREKA survey).	$ 450,000
Total for Year #4	**$ 1,010,000**
Total for 4-Year Program	$ 4,410,000

The above cost estimates are based on a rate of $40 per hour for shipyard work, $35 per hour for non-shipyard contracted work, and $30 per hour for in-house work.



HERCULES towing log raft into San Diego, 1909.

E. The Steam Tug HERCULES

1. Particulars:

Length, registered:	134 ft. 11 in.	Draft, maximum:	14 ft 0 in.
Beam, maximum:	26 ft. 1 in.	Gross tonnage:	414
Depth:	18 ft. 0 in.	Net tonnage:	221

Builder: John Dialogue & Sons, Camden N.J., 1907

Hull, decks: Riveted steel. Superstructure: Steel

Machinery: Triple expansion engine, 500 hp., single screw
Oil-fired Scotch boiler, four-furnace, 177 lb. pressure

2. History and Relevance

When launched, HERCULES was one of the largest and most powerful tow boats of her time. She was built for long distance offshore towing and immediately proved her prowess in delivering herself, with her sister ship in tow, from New Jersey to San Francisco by way of the Straits of Magellan. Owned by the Shipowners and Merchants Tugboat Co., she worked the lumber trade along the West Coast from Alaska to Central America. Towing massive log rafts, HERCULES competed with lumber schooners such as C.A.THAYER and WAPAMA.

By 1941, railroads and trucking had all but eliminated the offshore towing business, but HERCULES retained her livelihood. She joined the Red Stack line of the Western Pacific R.R., and went to work towing rail-car barges across the Bay. Her pilot house was elevated at this time to provide visibility when towing alongside or "on the hip". This has been her only major alteration in eighty-one years.

HERCULES is a fine example of a type of vessel which has played a vital role in the development of the American West Coast. She has been an integral feature of the San Francisco waterfront, and a significant actor in its commerce and industry for the better part of a century.

3. Preservation History

HERCULES was acquired by the National Park Service in 1977, along with the rest of the State Historic Monument Fleet. Since then, she has been visible to the public at Hyde Street Pier, but has not been restored or made accessible to visitors. Some maintenance and restoration has been undertaken by volunteers, but her full restoration, interpretation and operation remain unrealized potentials.

4. Recommended Use

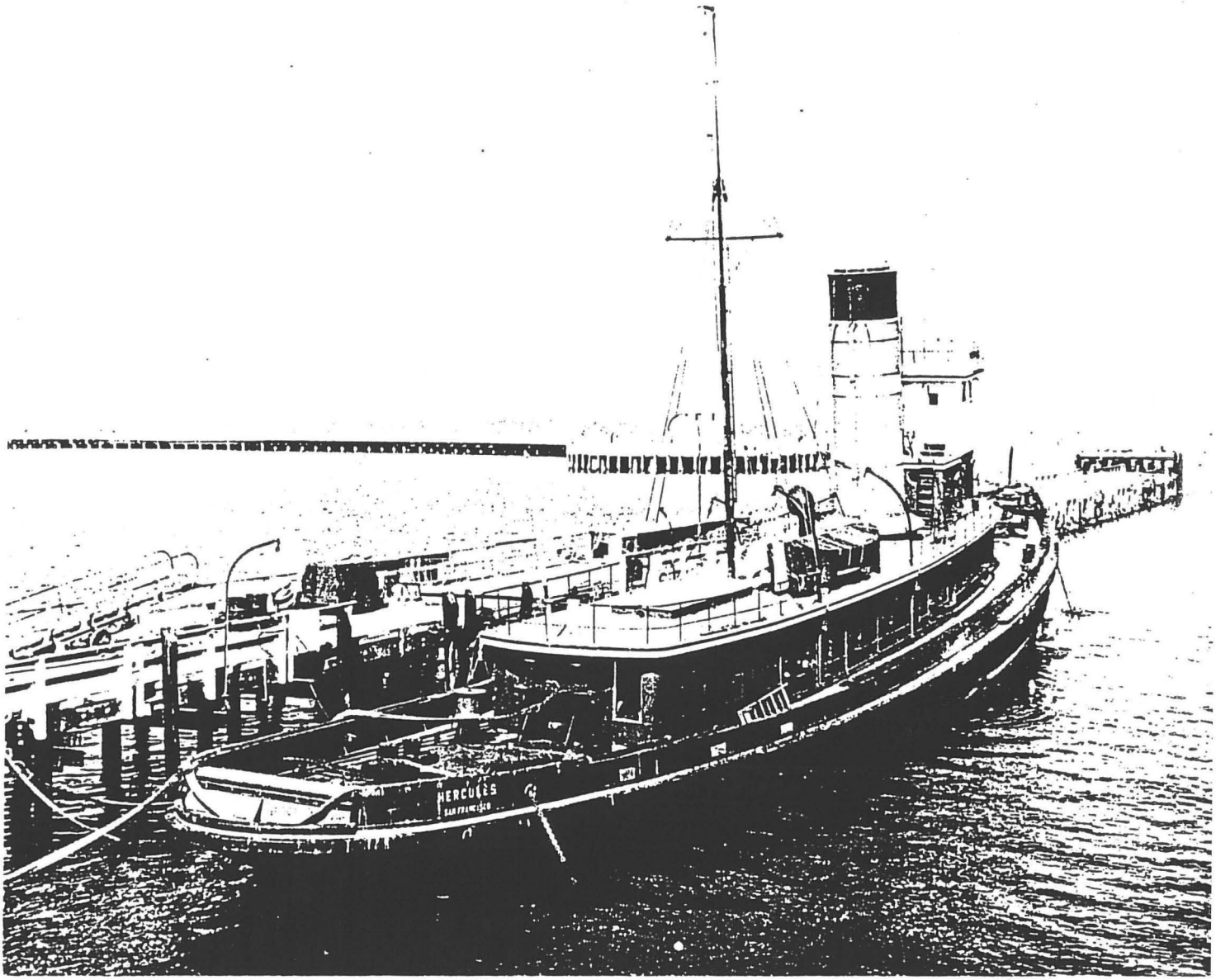
HERCULES can and should be restored to steaming condition, for limited operation several times a year. It is also recommended that provision be made for getting the public aboard for a tour of the the main deck level. As an adjunct to both interpretation and maintenance, it is further recommended that steam be raised on a regular schedule while at the dock.

The best model for usage of HERCULES is probably the operation of the liberty ship JEREMIAH O'BRIEN, which is run by a private foundation under a cooperative agreement with the Park Service. O'BRIEN steams from Fort Mason on bi-annual excursions and has live steam raised at the dock one weekend per month. She is open daily as a stationary museum ship with a small admission charge. A very active and dedicated volunteer program is the essential component in this organization.

With minor modifications for visitor safety, the public could be permitted aboard the main and boat deck of the HERCULES. A traverse of the upper levels of the engine and boiler rooms would give a view of the most important interior spaces. The ship offers rich interpretation possibilities for a relatively low level of expense.

Having live steam at the dock would permit operation of the machinery, encourage volunteer participation, aid in maintenance, and increase the level of interpretation, even if only one weekend a month were scheduled for steam operation. It will be advisable to supply steam from a donkey boiler (a much smaller boiler than that on HERCULES), as repair of the ship's main boiler is still some distance off. If this alternate source of steam could be put on line, work could progress on the machinery. Another important reason for activating the donkey boiler is that the main boiler, when restored, will require eighteen hours to raise steam. In addition to the need for qualified personnel to supervise this process, fuel consumption would be considerable.

Restoration of HERCULES to steaming condition is not the highest priority for the fleet, but it can be accomplished for a lower cost than many of the other projects, and offers a very high public impact. Restoration and subsequent operation may best be accomplished by cooperative agreement with a private foundation. Such a venture must be entered into with adequate safeguards for the vessel and will require active participation by NPS. The primary advantages to such a cooperative arrangement are the potential for private fund raising to supplement available federal funding, and the increased volunteer participation that may be attracted to the ship.



Steam Tug HERCULES at Hyde St. Pier

A rough assessment of the shell is that 50% (the upper topsides and upper bottom) is adequate; another 25% (the wind-and-water line) has been stabilized and repaired; an additional 25% (below the bilge) is still dangerously thin. This last is a most serious problem and, unless repairs are made before further deterioration occurs, will increase the danger of sinking.

The deck has been repaired by doublers over the years and is due for some further work, but is not yet critical. The bulwarks and guards are in poor condition, but do not endanger the vessel, except by contributing to the continued deterioration of the topsides.

c. Superstructure

The superstructure consists of the steel deckhouse, wooden boat deck, steel pilot house, and stack. The deckhouse has numerous localized areas of corrosion, none of which require immediate attention. The boat deck is leaking in many places, and while temporary patches may ameliorate the problem in the short term, any permanent repair will probably require renewing at least one third to one-half of this deck. The pilot house is neither original nor attractive, but it is part of the ship's working history and the least deteriorated of any part of the ship. The stack has numerous areas of exterior corrosion. An internal survey will be required to determine the best method of repair. It is not considered an immediate liability.

d. Machinery

The machinery is largely intact, in the sense that almost all of the pieces are still in place, but is a long way from being operational. The main engine is complete (except for the condenser, which has been disassembled for retubing) and was known to turn over freely in 1982. Most of the auxiliaries are complete and have been run on compressed air in the last few years. The boiler is considered repairable to operating condition, although probably at a reduced pressure.

On the negative side, the foundations of the main engine and boiler are suspected of being severely corroded beneath the bilge cement. The fuel tanks are not tight to the deck, and are grossly oversize for any future needs of occasional steaming, but are in good condition internally. The wiring was not surveyed in detail but is suspected of being at least partially deteriorated, as leakage through the decks has been chronic and is ongoing. The piping was not surveyed but is also suspect; given the age of the vessel it is reasonable to expect a need for renewals.

On balance, the ship is fortunate in that all of the major components of her machinery, which would be either impossible or extremely costly to reproduce, are in place and either intact or readily repairable. The amount of work needed for full restoration is daunting in quantity, but straightforward in kind.

e. Equipment

Like her machinery, HERCULES' equipment has a long way to go in terms of restoration to operational condition, but the most significant items are still aboard and largely intact. The gear which appears to be missing is mostly on the level of small furnishings.

In summary, HERCULES is largely intact and much of her is in reasonable condition, thus making full restoration an achievable goal. In relative terms, HERCULES can probably be brought to an operational condition for less money than will be needed to achieve a minimal maintainable status for some of the other vessels in the fleet.

6. Recommended Steps

This section outlines a sequence of steps for achieving a full restoration of HERCULES to operating condition. The recommended schedule for this restoration is one which permits completion within a time span sustainable by the key people involved. This applies to donors as well as volunteers and staff. If a project drags on for too long, interest decreases and overhead increases, with the result that less is accomplished over a given period. The rationale for making the HERCULES restoration a high priority is for NPS to avail itself of private efforts. Therefore, the recommended schedule would have all stabilization and planning done within one year, the vessel steaming at the dock within two years, operational within three years, and completely restored within four years.

FY 88: Phase I

This phase will lay the groundwork for beginning actual restoration.

1) Carry out the short term recommendations from the TCM survey; these are all aimed at stabilization and upgrading of basic maintenance.

2) Contract for bilge cleaning in the engine room to facilitate further survey work and as part of general maintenance.

3) Commission a full set of drawings for the ship. Accurate drawings will be needed in the planning and execution of restoration work.

4) Develop a restoration plan which must:

   a) establish the scope of work and develop specifications for carrying out the work;
   b) identify the personnel resources available in NPS staff, private foundations, volunteer organizations, and contractors;
   c) based on scope of work, outline a realistic work schedule;
   d) develop a funding plan which defines need, identifies sources, and is synchronized with the work schedule.

5) Restoration of HERCULES can best be accomplished by a joint effort between NPS and a private non-profit group. The present volunteer group, as it is now constituted, is small, has no formal organization, and would have difficulty administering a large scale project. The members of this volunteer group, however, have shown persistence and dedication, and many of them possess precisely the skills needed for restoration of the ship. The efforts of the volunteers should be given every encouragement, but all parties concerned must realize the full magnitude of the task which lies ahead. Developing a plan, let alone implementing it, will require establishing a formal agreement regarding responsibilities, a decision-making process, a chain of command, accountability, etc.

   It is often the case that even the most vigorous volunteer programs require the presence of one or preferably two full-time salaried staff to manage the ship and maximize volunteer effectiveness (and therefore, volunteer satisfaction). The Museum Association should be urged to develop the funding for these positions.

   In evaluating the future usage of HERCULES, and means of accomplishing her restoration, it may be worthwhile to explore the possibility of a cooperative venture with the JEREMIAH O'BRIEN Foundation. Such an arrangement could benefit both vessels.

6) The HERCULES volunteers have submitted a proposal for temporarily relocating the ship to a slip at lower Fort Mason, in order to facilitate access by both volunteers and contractors. HERCULES' restoration efforts would very likely be furthered by improving access to her in this way. Before the ship is moved however, it is strongly recommended that adequate provisions be made in a number of areas, including those for a safe brow, bilge alarms, power for bilge pumps, proper moorings, general service electricity, and a fire main. The coordination of activities between NPS and the volunteers is extremely important and must also be facilitated at the new location.

FY 89: Phase II

Completion of the detailed restoration plan in Phase I will provide a clearer picture of the remaining phases of the project. The subsequent phases of this outline are therefore addressed in more general terms.

The priority of Phase II will be to restore structural strength to the hull, and to complete such additional work as will be needed to run dock trials.

1) Drydock the vessel to determine the full extent of necessary hull renewals. The lines of the hull should be taken at this time.
2) Renew wasted bottom shell and machinery foundations.
3) Make permanent repairs to main deck.
4) Repair piping and wiring.
5) Make provisions for live steam: from dock, or donkey boiler on vessel.
6) Overhaul main engine and auxiliaries.
7) Complete main boiler work.
8) Concurrent with drydocking, make needed repairs to shafting, bearings, propeller, and rudder.

FY 90: Phase III

The priority in Phase III will be to get the vessel underway.

1) Repair stack.
2) Overhaul steering gear, windlass, and all other equipment needed for safe navigation.
3) Rebuild fuel tanks to a smaller configuration, perhaps utilizing the center-line and thwartship bulkheads, adding new plate for top, bottom, and outboard sides. This modification of the tanks will make them non-integral with the shell, thus eliminating the need to "gas-free" them every time hot work is to be done on the adjacent shell.

   The ship will never again require anything close to her original fuel capacity. If the existing tanks have only a little fuel in them, she will ride high. With smaller, non-integral interior fuel tanks, the remainder of the original tanks can be used for water ballast when underway, and kept empty for ease of inspection and reserve buoyancy when moored.

4) Get vessel ready for operation; beginning with crew training and dock trials, work up to the final steaming program. Make all necessary installations and provisioning including safety gear, emergency generator, fuel, and other consumables. Getting underway as soon as is safely possible will be the greatest catalyst in completing the restoration.

FY 91: Phases IV and V

Phase IV

The priority of this phase will be the completion of structural repairs.

1) Renew guard rails.
2) Repair bulwarks and renew caprails.
3) Scale and coat water tanks.
4) Renew boat deck.
5) Repair deckhouse.

Phase V

This phase will concentrate on completion of the details of restoration: replicating boats, minor items of outfit, increasing depth of interpretation, and finishing interior spaces. At this point, decisions should be made regarding restoring the original wooden mast arrangement, and replacing the later steel pilothouse with a replica of the original wooden pilot house. The steel pilothouse is historic in that it was on the ship for much of her working life. However, the ship's greatest significance is in her earlier period in the coastal trade for which she was built. For that period, which is also contemporary with the rest of the historic fleet, the original pilothouse would be more appropriate. It is also generally considered to be the more visually pleasing configuration. If the decision is made to replace it, preservation of the steel pilothouse ashore is recommended.

7. Table of Cost Projections, HERCULES

The following cost figures are estimated at commercial rates for both shipyard, and other contracted work.

FY 88: Phase I

1)	Stabilization measures		$ 54,000
2)	Bilge cleaning		$ 25,000
3)	Drawings		$ 40,000
4)	Restoration Plan: all design and engineering		$ 70,000
5)	Start up costs: cooperative agreement, NPS overhead		$ 50,000
6)	Develop Restoration berth:		
	Moorings	6,500	
	New Brow	20,000	
	Utilities	10,000	$ 36,500
Total for Year #1			**$ 275,500**

FY 89: Phase II

1)	Drydocking, survey, lines taking	$ 60,000
2)	Shell and foundation renewals	$ 350,000
3)	Permanent main deck repairs	$ 20,000
4)	Repairs to piping and wiring	$ 200,000
5)	Provide donkey boiler, steam line	$ 20,000
6)	Overhaul of engine and auxiliaries	$ 50,000
7)	Repair of main boiler	$ 70,000
8)	Repairs to shaft, bearings, propeller, rudder	$ 50,000
Total for Year #2		**$ 820,000**

FY 90: Phase III

1)	Stack repair	$ 20,000
2)	Overhaul of navigation equipment	$ 30,000
3)	Installation of fuel tanks	$ 30,000
4)	Begin operations: surveys and inspections, insurance, key professionals, safety gear, consumables.	$ 50,000
Total for Year #3		**$ 130,000**

FY 91: Phases IV and V

Phase IV

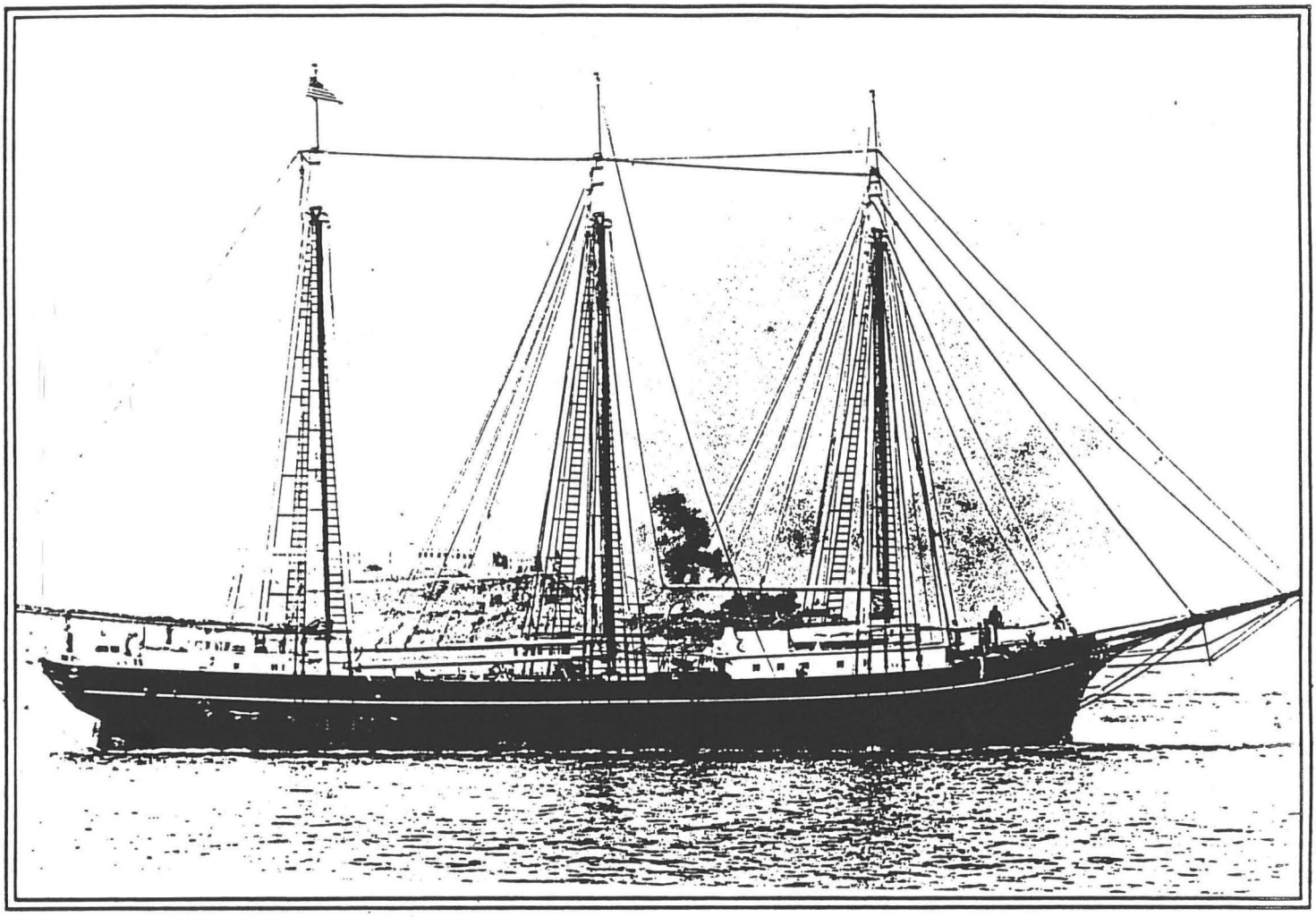
1)	Renewal of guards	$ 60,000
2)	Renewal of bulwarks and caprails	$ 100,000
3)	Scaling and coating water tanks	$ 30,000
4)	Renewal of boat deck	$ 75,000
5)	Repair of deck house	$ 75,000
Sub-total		$ 340,000

Phase V

1)	Replication of boats (3)	$ 12,000
2)	Restoration of wood masts and rig	$ 30,000
3)	Restoration of wood pilot house	$ 50,000
4)	Miscellaneous outfitting	$ 35,000
5)	Interpretation	$ 30,000
Sub-total		$ 157,000
Total for Year #4		**$ 497,000**
Total for 4-Year Program		$ 1,722,500

Volunteer Contribution

Of the total cost, approximately 25% will be for materials, and 75% for labor. The labor component represents approximately 32,000 man hours. With the present level of volunteer labor at 2,000 man hours per year, the volunteers could be expected to meet one-quarter, or 8,000 hours, of the total labor requirement over the four year period. This would reduce the total project cost by approximately $ 323,000 or 19 percent. This figure would increase proportionately with an increase in the volunteer effort. In addition, solicitation of in-kind donations of materials and services could further reduce the total project cost.



THAYER in tow to drydock, 1971.

F. Three-mast Schooner C.A. THAYER

1. Particulars

Length, registered:	156 ft 0 in.	Gross tonnage:	452
Beam:	36 ft 0 in.	Net tonnage:	391
Depth:	11 ft. 8 in.		

Built: Capt. Hans Bendixsen, Fairhaven, California, 1895, for E.K. Wood Lumber Co.

Hull, decks, superstructure, spars: wood

Machinery: steam donkey engine in deckhouse

Rig: three-mast "bald-headed" schooner, gaff fore and main, triangular spanker

2. History and Relevance

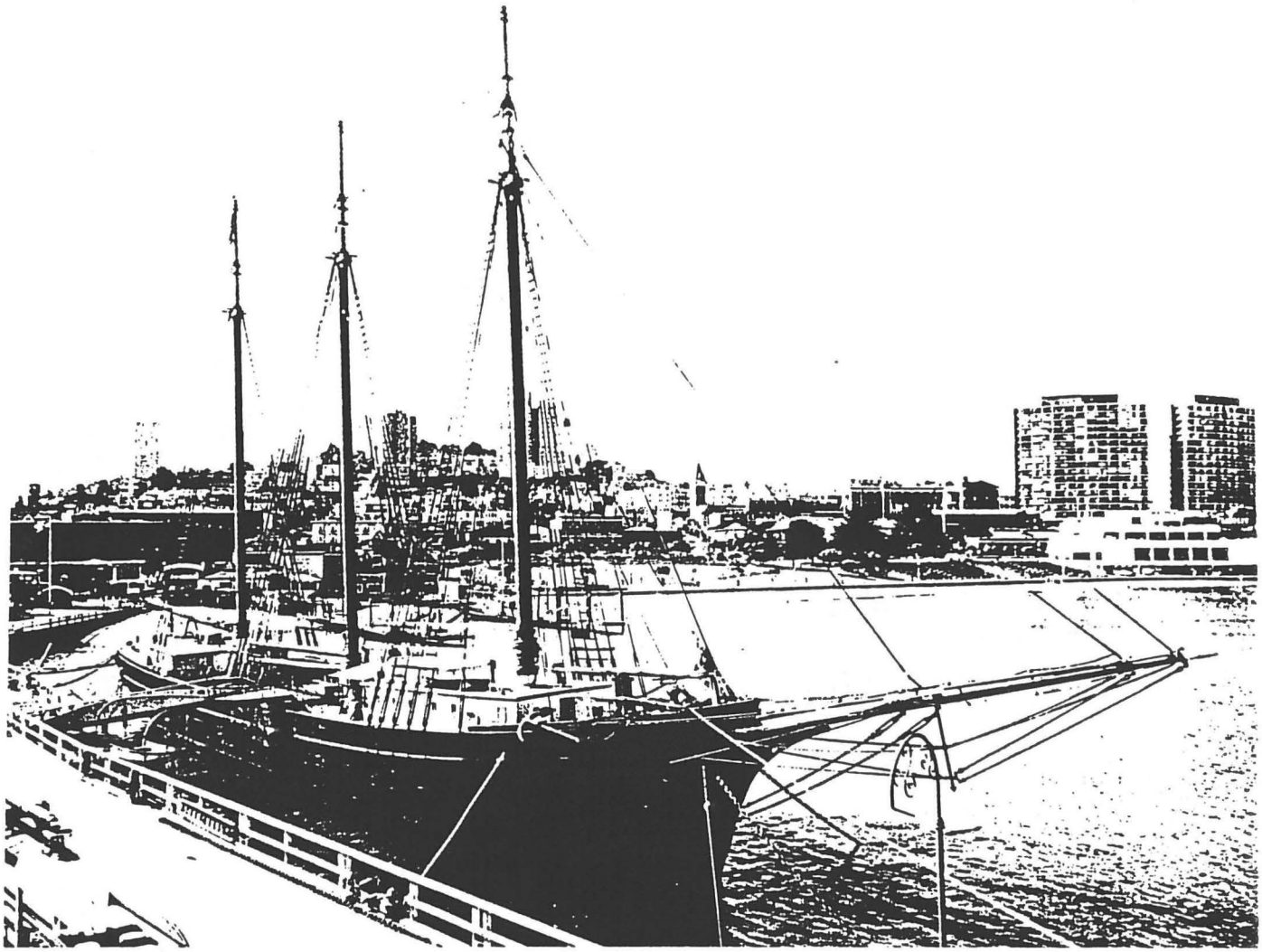
C.A. THAYER is one of the last two survivors of a large fleet of wooden West Coast lumber schooners. These vessels were built to deliver the redwood and Douglas fir of which San Francisco and the other cities of the West Coast were primarily built. It was a rugged trade, along a stormy lee shore, nearly devoid of protected harbors from Puget Sound to San Francisco, and southward. Lumber harvested from the coastal forests and inland along the rivers of Oregon, Washington and Northern California was sawn and shipped from a series of "doghole ports", little more than indentations on the rocky coast. Loading in many cases was accomplished by chute, wire or lighter to vessels held in position by anchors and moorings. It was a trade which demanded maneuverability and weatherliness from a sailing vessel, as well as cargo capacity and a shallow draft. These demands produced one of the last great refinements of the American coasting schooner, of which THAYER is a typical example.

THAYER's working life has been far longer than that of the typical lumber schooner. She worked at first in the coastal lumber trade, with offshore passages to Mexico and the Pacific islands. By 1912, the difficult coastal service was largely taken over by the more dependable steam schooners, represented in the NPS fleet by WAPAMA. THAYER then entered the Alaska fisheries trade, making seasonal passages delivering fishermen and supplies to the salmon packing plants, and delivering the season's product to San Francisco. This was one of the last trades in America which could economically be undertaken by sailing vessel, and was responsible for extending the lives of many other fine vessels, including BALCLUTHA and STAR OF INDIA.

The high freight rates and shortage of shipping during World War I made it profitable to send THAYER on deepwater cargo passages as far as Australia. After the war she resumed service with the Alaska Packers.

In 1926 THAYER was turned to the seasonal cod fisheries of the Bering Straits, carrying fishermen, boats and salt to the banks for a six-month cruise, and delivering the salted fish back home. This long period of salt and brine infusion in THAYER's hold made its own contribution to the vessel's longevity. After serving as a barge for the U.S. Army during the Second World War, THAYER made five more voyages in pursuit of codfish before her final lay-up in 1950.

C.A. THAYER has been a working part of the San Francisco waterfront and the Pacific Coast for over half a century. She is a now-rare example of the flowering of West Coast wooden shipbuilding, and a significant member of the historic fleet at San Francisco.



C.A. THAYER at Hyde St. Pier in 1981.

3. Preservation History

In 1955, the California State Division of Beaches and Parks was authorized by the State Legislature to purchase a steam schooner and a sailing lumber schooner. THAYER was purchased in 1956, and restoration began in Puget Sound. Partial repairs were made to her hull in Seattle, where she was also re-rigged and prepared for her last passage under sail along the coast to San Francisco.

The voyage was made in 1957, and further restoration was undertaken upon her arrival in Oakland. In 1963 she was towed to Hyde St. Pier in San Francisco to become part of the State Maritime Historic Monument. She was fully interpreted, with captions on deck and in her restored accommodations. A "By-word" audio guide system provided a tour of the vessel, and exhibits in her hold and forecastle told of the lumber trade and Pacific fisheries. She has remained at this station, with periodic haul outs, for the last 24 years. During this time she has received a multitude of visitors and hosted an environmental living program for children. She remains an important part of San Francisco waterfront activity.

4. Recommended Use

C.A.THAYER should continue her successful role as a floating museum ship, with perhaps an expansion of her present programs. The rebuilding required to keep her afloat, and in maintainable condition, will also allow her to sail on limited excursions. This is considered a feasible, and highly desirable, use for the vessel. The advantages and disadvantages of such operational usage will need to be assessed in greater detail, but there is no doubt that the interest generated will benefit the maintenance of the vessel, if not the entire fleet.

It is not recommended that original fabric be replaced solely in the interest of sailing the vessel. The justification for such treatment should lay in the need to preserve the vessel as a whole. The 1986 survey established the necessity of renewing major portions of original fabric in order to keep the vessel in floating condition, though questions still remains as to degree.

5. Summary of Existing Condition

a. Summary

C.A. THAYER is in adequate condition to continue her function as a floating exhibit over the short term. With the possible exception of the electrical system, no serious safety liabilities exist at this time. Her problems lay in the extensive decay which has been spreading for many years until it has now permeated most of her structure. This decay has rendered the vessel difficult to maintain, and will require a major effort to arrest, and an even greater effort to reverse.

Despite her present condition, C.A. THAYER has displayed a remarkable resistance to the elements, and has therefore retained her form and much of her original fabric. This is largely to the credit of her builder; she is very well constructed, using an adequate number of fastenings, and long lengths of high quality timber.

b. Hull

The hull suffers from rot and hogging, but its outward appearance does not convey the severity of either. Although rot is visible inside and out, the worst decay is hidden from view. The considerable hogging, as measured along the keel, has not yet caused the unsightly drooping of the sheer which is characteristic of this condition.

1) Interior

Approximately 85% of the **framing** shows some degree of decay at the upper ends, in way of the clamp and upper ceiling. This condition is consistent from the forepeak to the stern, though a series of frames under the port side of the quarter deck appear to be in better condition. The probable cause for the general decay of framing in the upper hull is freshwater seepage through the rotten and deteriorated waterways, covering boards, bulwark stanchions, and topsides planking. Sealing these areas constitutes the bulk of needed stabilization work.

The condition of the **frames and floors** in the lower hull appears no better. Of the twenty test borings taken at or below the turn of bilge, only four revealed sound wood. Areas of severe rot exist in the floors below the forecastle sole, and at the aft end of the hold. A further indication of rotten framing is seen in the sprung topside plank butts, particularly on the port bow. Here the curved planks have straightened out as their fastening pull away from the rotting frames.

With the exception of the port side of the forecastle, the general appearance of the **clamp and ceiling** is good, thus giving the impression of soundness. The problem is to be found on the outboard face of the clamp and ceiling planks, and inside these timbers, where there is widespread decay.

The **clamp and ceiling** are in fair condition in the forepeak, with the exception of a few rot pockets at deck beams, but become more deteriorated as they extend into the forecastle. Here, the ceiling has soft or rotten areas throughout. Underneath the forecastle sole, the ceiling is in very poor condition, largely because of the poor ventilation and constant moisture in this area. Cracks, possibly due to hogging stress, can be seen in both port and starboard clamps. The majority of the ceiling in the hold is sound on the surface but decayed inside or on the outboard face. An estimated 65% of all ceiling suffers from this condition.

The **keelson and sister keelsons** are rotten variously, with the worst area being under the main hatch. The **stem and sternpost** appear in generally good condition.

2) Exterior

Much of the topside planking on the port side is extremely deteriorated, and the seams are open. This condition is seen in about 40 % of the area, with the remainder of the planking being fair to moderately rotten. Of primary concern is the generally deteriorated condition of the planking at the waterline. Plywood sheathing has been fitted along the entire waterline, in order to protect this area. The sheathing appears to be holding up, but can only be considered a temporary measure.

The starboard topsides are in much better condition, with only about 20 % of the planking rotten. Most of the stern planking is rotten, but the stern framing is in good condition, having been replaced with hardwood during the rebuild in the late 1950's. The entire stern is beginning to sag downward under the load of the stern mooring bridle.

The underwater hull has not been inspected since drydocking in 1983. Judging by the rate at which bilges fill with seawater, it can be expected that much of the caulking, and possibly some of the planking, has deteriorated. The hull may also be flexing due to its weakened condition, thus increasing seepage at plank seams and butts. Drydocking will be necessary to further assess the condition of the bottom.

c. Decks

1) Main Deck

The exposed portion of the main deck is in very poor condition and leaking. This is the section of deck extending from the break of the forecastle deck to the quarter deck bulkhead. The worst conditions are seen in the area between the mainmast and the quarter deck bulkhead. General condition of planking includes soft seams and butts, missing bungs, and deteriorated caulking.

The **deck planking** is generally still sound enough for foot traffic, though some local areas of severe rot and weakening exist. The deck is "dished", or concave, due to weakened and sagging deck beams along the main hatch. As a result, rainwater runoff is poor.

The **waterway timbers** are internally decayed along most of their length, particularly between the forecastle head and the quarter deck. This is significant because the waterways are major longitudinal members of the upper hull.

Deck beams generally show advanced decay in those areas where the deck planking or waterway are in poor condition. Much of this decay is in the beam tops and extends into the heart of the timber, thus creating a "hollow" beam which visually appears in good condition. Decay is worst at the beam ends and at carlings in the way of the hatches. All deck beams under the exposed portion of the main deck are hollow or rotten at the ends. The beams aft of the quarter deck bulkhead are in better condition, with only slight hollowness at the ends.

Most of the **hanging knees**, which support the ends of the deck beams, show some degree of internal decay. About one-half of the **hold pillars**, which support the middle of the deck beams, are soft at the upper or lower end.

Despite the general deterioration seen in the deck planking, beams, knees, and pillars, the main deck is not considered to be in danger of collapse in the near future.

2) Forecastle Deck
Forecastle deck planking is newer than the main deck, and is in good condition with no signs of decay. The pitch is slightly hollow, cracked and in need of repaying. Deck beams are sound, except at the outboard and the clamp is rotten in one location on the port side. The forecastle bulwark timbers have some local soft areas, but all other items on this deck are sound.

3) Quarter Deck
The quarter deck is in much better condition than the main deck. Most of the **quarter deck planking** is in good condition, with only local areas of rot which are be repairable. The deck beams are also in generally good condition, with exception of some of the short beams along the cabin trunk, and the beam at the rudder post. The quarter deck clamp is rotten or hollowed out along much of the starboard side; the port clamp has been repaired.

The **waterways** show decay in numerous locations along the sides, and across the stern. The taffrail and log rail around the quarter deck are also soft or rotten locally. Rot in these rails appears to follow the pattern of the rot seen in the waterway timber beneath, indicating the spread of decay from one member to the other.

The **cabin trunk** has scattered areas of decay but is in good condition overall. The planking on the trunk top is generally sound, with only minor rot pockets and signs of incipient rot. The **quarter deck bulkhead** exterior is in poor condition with severe rot in the sill and the tongue and groove sheathing.

The accommodations area below the quarter deck, including captain's and mates' cabins, are in good condition.

d. Other Structures

Many of the **bulwark stanchions** and large sections of bulwark planking are severely rotten or totally disintegrated. The starboard side appears in worse condition, probably owing to the more direct exposure of sun and weather on the inboard side. All of the one hundred bulwark stanchions show some degree of decay. The bulwark cap appears to be a renewal and is in marginal condition with localized rotten or hollow areas at the scarfs.

Portions of the **deck house** are rotten, the worst being the sill, which is severely decayed in some places, and the top, which is rotten around the edges. The sides of the house are also affected. The deck house interior is in good condition.

The **fore hatch** coaming and carling are rotten in some places. The main hatch carling is also partially rotten, but the coamings are in good condition. Both hatches would need to be rebuilt or renewed as part of a rebuild of the main deck.

e. Rig
The rig is in good condition overall, having undergone a refit in 1983. All of the masts and the bowsprit where renewed at that time. They are sound, with the exception of a small rotten area seen at the main mast hounds. The booms and gaffs are older and some decay is seen, particularly in the mizzen boom which is totally rotten at the outboard end and will need to be renewed.

The standing rigging is old, but still retains sufficient strength for an inactive rig. The shrouds are somewhat slack, and all of the standing rigging is in need of tarring and other maintenance. Many of the iron chainplates show considerable corrosion and require scaling and coating. Some of these fittings have also lost material due to wear.

f. Electrical System
There are numerous deficiencies in THAYER's electrical system, some due to deterioration, and others the result of improper installation. Much of the wiring in the hold has suffered from leakage of the main deck. The entire system is in need of reworking and upgrading to meet modern electrical codes.

6. Recommended Steps

To continue in her role as a floating museum ship, THAYER must eventually undergo an extensive structural rebuild. The key question is whether enough of her original fabric, particularly major structural members, can be retained to warrant a rebuild of the hull. It is generally not considered worthwhile to disassemble a vessel in order to replace every component; the cost of such a project would be far in excess of the cost of new construction, and would result in the loss of all historic fabric. If, due to her deteriorated condition, some minimum portion of THAYER cannot be retained, it would be more logical and cost effective to preserve the vessel ashore, or lay down a new keel and build a replica, or both.

What this "minimum" amount of fabric would be is open for debate, but would certainly include the keel, keelsons, and majority of the ceiling. The keel and keelsons form the backbone of the ship and would be difficult to replace without total disassembly of the hull. The ceiling would also be very difficult to renew in its entirety, and further, would represent a significant loss of historic fabric; etched on its visible surface is the patina of years of active service.

Based on the recent survey, these components are known to already be partially deteriorated, but are felt to be retainable with some effort, possibly with the use of modern preservation technology. If allowed to deteriorate further though, a rebuild may soon be out of the question. A high priority has therefore been placed on stabilization measures, most of which are intended to keep rainwater out of the hull, and thus prevent further decay of the keelsons and ceiling.

a. What Has Been Done to Date

Recent accomplishments toward stabilization have been significant. The following work has been performed since the existing condition survey in early 1987.

1) Leaks in the main deck have been greatly reduced by bumping down the existing caulking and paying the seams with pitch.

2) The open seams and rotten areas of the topsides planking have been sealed, and the entire topsides painted. In addition, several sprung plank butts were refastened.

3) The rotten and disintegrated bulwark stanchions have been sealed and painted.

4) Modifications have been made for shifting the stern mooring bridle to a more secure point further forward. This will help reduce the hogging strains on the stern.

5) A design has been developed for a seasonal cover to go over the main deck. Materials have been purchased for fabrication.

b. FY 88: Priority 1 - Additional Stabilization Work

The following steps are recommended for the next fiscal year.

1) Calculate the hogging/sagging strains on the hull. This will involve developing a loading curve for the vessel. These calculations are necessary in order to determine corrective measures. The hull should not be allowed to hog further, as this distortion is largely irreversible, even with major rebuilding.

2) The seasonal covers should be fabricated and installed as soon as possible. Even if the rainy season passes before the covers are erected, they should be assembled on a trial basis so that they can be rapidly deployed at the start of the next season.

3) Drydock vessel for survey, coating, and any necessary hull repairs. Hull repairs might include renewal of a few worm damaged bottom planks, and replacement of deteriorated plywood sheathing. THAYER has not been drydocked since 1983 and is overdue for this work. Even though the vessel would be drydocked again within two years, if the full rebuilding proceeds according to this schedule, this drydocking is essential. It will allow surveys and assessments which will be necessary for developing a rebuilding plan. It would also allow installation of a steel keel shoe which would form a foundation for the backbone during rebuilding.

4) Based on the loading curve, design, fabricate and install buoyancy chambers and/or ballast. This work would be done concurrently with drydocking and would include installation of the aforementioned steel keel shoe. This would be a girder attached to the bottom of the keel, and would be straight along the bottom and formed to match the hog of the keel on top. The advantages would be in ballasting, longitudinal stiffening, and ease of blocking for drydocking.

5) Develop and begin a rot treatment program. Regardless of the timing of a rebuild, rot in the existing hull structure should be arrested. The most applicable treatment is likely to be the borate system now being tested on WAPAMA. An assessment of the results of this testing should be made before beginning treatment on the THAYER.

c. FY 89: Priority 2 - Planning, Procurement, and Project Set-up

Without further information, in the form of a comprehensive plan, only a general outline of a logical rebuilding sequence can be given. There are two major approaches which can be taken to the project. One is to contract out most of the job. The Museum would provide the initial planning and engineering, and the quality assurance, and a single contractor would run the project, supervising any sub-contractors. Materials could be provided either by the Museum or the contractor.

The other approach would be to retain the management and supervision of the project in-house, using contractors as needed for specific tasks. This approach would probably be the most cost effective and would allow the Museum more control, but would place the greater burden on the staff. Several combinations of these two alternatives are also possible.

The decision on which approach to take will depend on several variables and cannot be made at this time. The in-house approach is outlined here for the sake of discussion. Most of the tasks scheduled for FY 89 will be necessary regardless of which approach is taken.

1) Develop a project plan. The plan will include all major engineering, specifications, schedules of materials, work sequences, and time lines. The engineering will be important, as it will need to address not only the construction details, but also the technical difficulties inherent in phasing the work. Dividing the rebuild into two or more distinct phases is considered essential to ensure that the vessel can be reassembled, rather than left in pieces, if it should become necessary to put the project on hold for an extended period.

2) Locate and purchase materials. This will include the majority of the lumber and fastenings, as well as other materials for which a long lead time can be expected. The most difficult items to acquire will be the specialized fastenings, and the larger timbers. The timbers will need to be in long length, and should be air-dried, old growth stock.

3) Purchase and modify a work barge. This would be for "drydocking" THAYER, and will allow the rebuild to be done at the Hyde Street Pier. This approach assumes that the necessary restoration facilities would already have been established at the pier. Modifications to the barge should include flooding valves, mooring attachments, a small storage facility, and possibly a shed roof to protect the vessel. After the THAYER rebuild, the barge could be used for other work, and would possibly be amortized with the savings from this one project.

FY 90: Priority 3 - Begin Rebuild/Restoration

In this general outline, the rebuild is carried out in two phases over two years, an extremely ambitious schedule. The work is sequenced such that, if need be, Phase I could be completed, and the vessel reassembled, before beginning Phase II.

1) Drydock THAYER on barge and remove the rig and deck house.

2) Renew the upper portions of the hull, including: top futtocks, waterways, clamp, deck beams, decking, and top strakes of planking. Preserve ceiling. Restore hatch coamings, quarterdeck bulkhead, and deck house.

FY 91: Priority 3 - Complete Rebuild/Restoration

1) Renew lower portion of hull, including: lower futtocks, floors, and bottom planking. Preserve keel, keelsons, and ceiling.

2) Re-install rig, deck house. Refloat vessel.

7. Table of Cost Projections, C.A. THAYER

FY 88: Priority I - Stabilization Measures

1)	Calculate hog/sag strains.	$ 10,000
2)	Fabricate and install seasonal covers.	$ 30,000
3)	Drydocking:	
	towage,	$ 5,000
	docking, cleaning, painting,	$ 30,000
	plywood and plank renewal,	$ 20,000
	survey, tech. assistance.	$ 5,000
4)	Design, fabricate, and install buoyancy/ballast, install steel keel shoe.	$ 75,000
5)	Rot arresting treatment	$ 40,000
Total for Year #1		**$ 215,000**

FY 89: Priority 2 - Planning, Procurement, Project Start-up

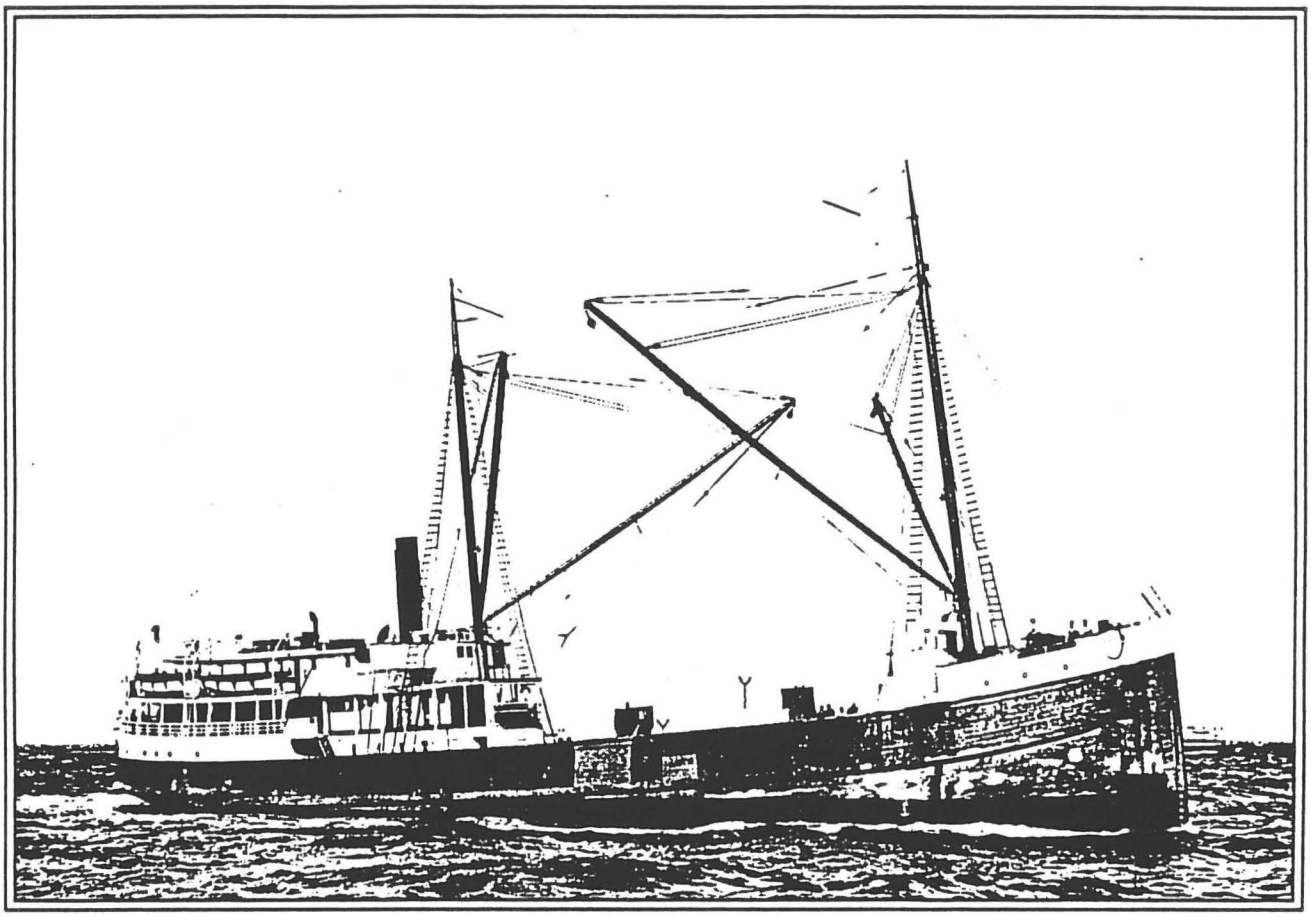
1)	Develop a restoration/ rebuilding plan.	$ 70,000
2)	Purchase materials.	$ 600,000
3)	Purchase and modify a work barge.	$ 420,000
Total for Year #2		**$ 1,090,000**

FY 90: Priority 3 - Begin Rebuild/Restoration

1)	**Drydock THAYER on barge, remove rig, deck house.**	
2)	**Renew the upper hull.**	**$ 2,000,000**
Total for Year #3		$ 2,000,000

FY 91: Priority 3 - Complete Rebuild/Restoration

1)	**Renew lower hull.**	
2)	**Re-install rig, deck house, Refloat.**	**$ 2,000,000**
Total for Year #4		$ 2,000,000
Total for Four-Year Project		$ 5,305,000



WAPAMA underway on San Francisco Bay, 1930's.

G. The Steam Schooner WAPAMA

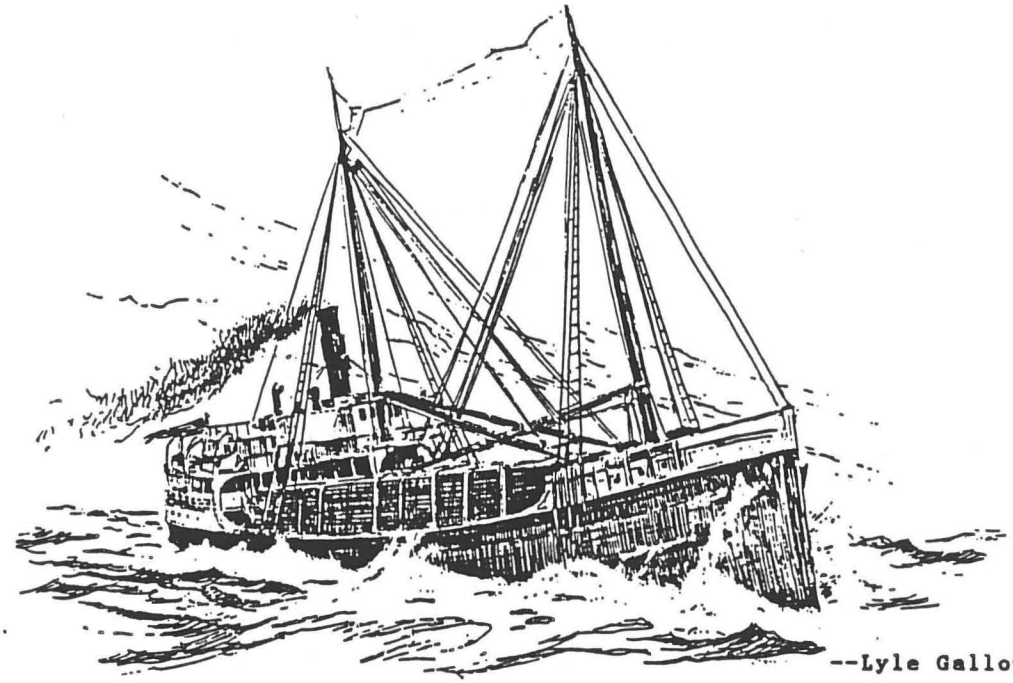
1. Particulars:

Length overall:	216 ft. 11 in.	Draft, maximum:	17 ft. 0 in.
Beam:	42 ft. 4 in.	Gross tonnage:	945
Depth:	19 ft. 0 in.	Net tonnage:	524

Built: St. Helens Shipbuilding Co., St. Helens, Oregon, 1915, for Charles R. McCormick Co., San Francisco

Hull, decks, superstructure, rig: Douglas fir

Machinery: Steam screw propulsion, triple-expansion engine, 800 hp., two oil-fired water tube boilers.



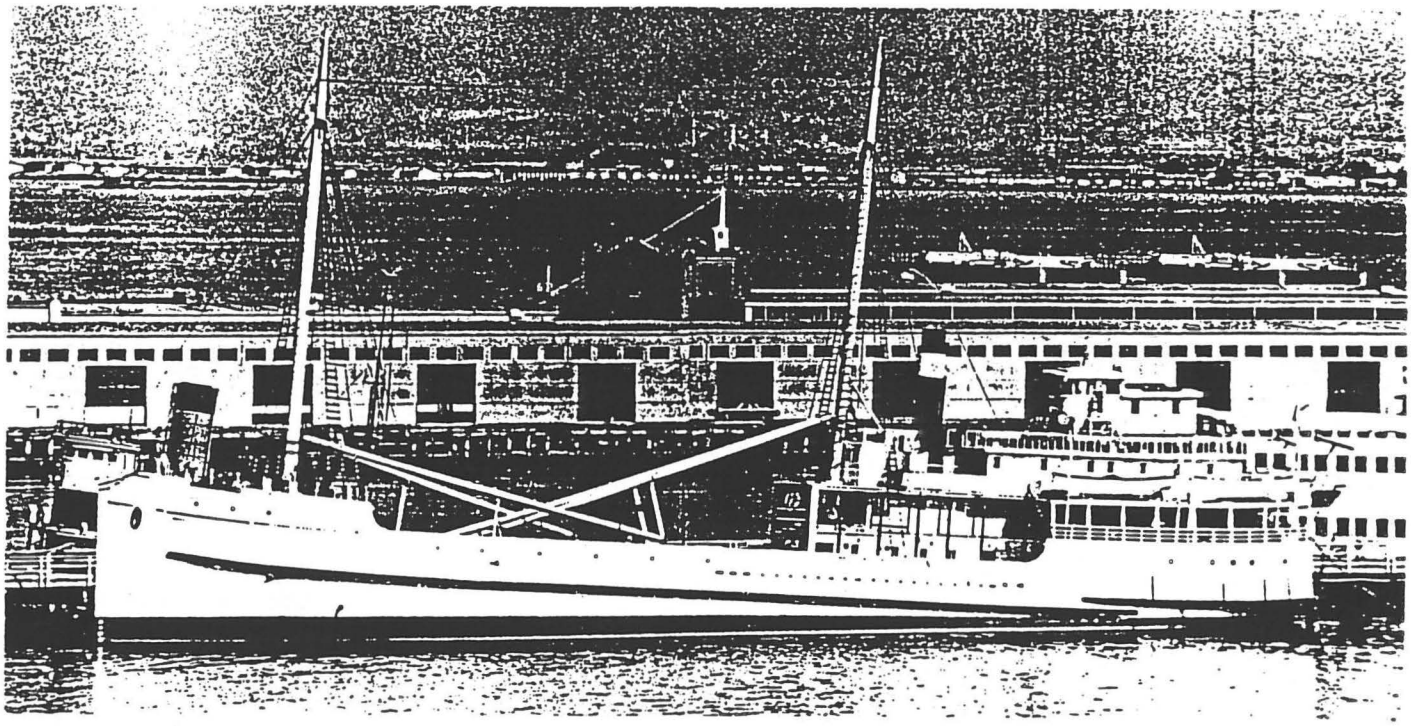
--Lyle Galloway

2. History and Relevance

WAPAMA is the last survivor of approximately 235 steam schooners built to serve the demanding lumber trade along the West Coast (see C.A. THAYER for description of this trade). Among the last large wooden vessels ever produced, WAPAMA is a fine example of the later development of wooden shipbuilding, and is a distinct and uniquely American type of considerable local significance.

WAPAMA was built on the wooded banks of the Colombia River in 1915, by a subsidiary of the Charles R. McCormick lumber and shipping companies. She was delivered in tow, with a full load of over 1 million board feet of lumber, to San Francisco for joiner work and installation of machinery. For the next fifteen years she carried lumber from her owner's lumber mills in Oregon to the growing cities of California, ranging as far south as Mexico. She carried passengers and general cargo on her return trips, steaming light against the prevailing wind and seas. By WAPAMA's time, the steam schooner trade had earned a worldwide reputation as a highly paid, good feeding and extremely hardworking berth for a sailor. It routinely demanded a high degree of navigational skill from its masters along a foggy, rock bound and storm tossed coast. So many seamen were drawn to this trade from Northern European deepwater ships that it was known as the "Scandinavian Navy", providing a foothold for a generation of immigrants to Northern California. As the principal means of transportation along much of the West Coast, the passenger service provided by steam schooner linked the ships to the general public in much of the region.

After a brief period in the San Francisco-Los Angeles passenger run, WAPAMA was sold to the Alaska Transportation Co. Renamed TONGAS, she provided passenger and cargo service between Seattle and Alaska. In 1947 she was laid up in Lake Union, then sold for scrap and delivered to Seattle in 1949. She was purchased by the State of California in 1957.



WAPAMA on exhibit at Hyde St. Pier.

3. Preservation History

A founding artifact and major reason for the inception of the California State Maritime Historic Monument, WAPAMA underwent extensive restoration from 1959 until 1963, when she was opened to the public at Hyde St. Pier. She had new spars, renewed decking and rebuilt passenger accommodations with many fully dressed spaces. She was interpreted with graphic captions throughout, and a By-Word tour, using oral history collected from steam schooner men by the San Francisco Maritime Museum. WAPAMA was an effective and popular exhibit.

In 1977, WAPAMA was transferred to the National Park Service with the other ships of the State historic fleet. A survey at that time identified severe structural deterioration. In 1979 she was moved to the AAA Shipyard in San Francisco, where she was hauled out on Barge 214 the following year. She was then moved to Pacific Drydock in Alameda and remained there for the next six years, her foremast removed and bisected, her booms, foredeck machinery and propeller transferred to the deck of the barge. In this laid-up condition, she was declared a National Historic Landmark in 1984.

In 1986, WAPAMA was shifted, still on Barge 214, to the U.S. Army Corps of Engineers' Bay Model site, where she is visible to the public, but not available for boarding. She is interpreted to some extent in the Visitors Center of the Bay Model, and by wayside panels on the pier. An Historic Structure Report, including record drawings and a preservation/restoration plan, was completed in 1987.

Today, WAPAMA is attended by a dedicated and active volunteer group under the direction of a full-time shipkeeper. This group has succeeded in addressing not only the stabilization needs of WAPAMA, but those of other vessels in the historic fleet.

4. Recommended Use

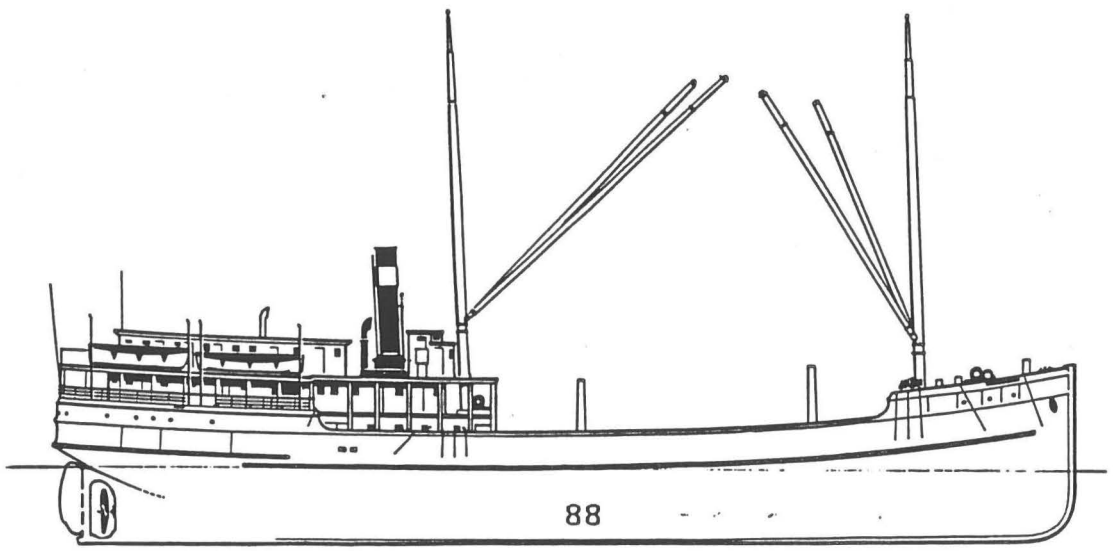
In 1985, a thorough structural survey confirmed what was generally believed: WAPAMA could not be returned to floating condition without a complete rebuild. Recommendations in the Historic Structures Report, produced in 1986, advised against a rebuilding of the vessel for reasons of cost, and concern for the loss of historic fabric such an undertaking would entail. Further, the Report recommended that an attempt be made to "preserve WAPAMA for future generations". This was viewed as a two-phase program beginning with stabilization. From the HSR:

" **Stabilization** is considered achievable and is recommended as the responsible short term goal. Stabilization is a precondition for any more ambitious preservation goals.

" **Long Term preservation** with public access is considered the best possible end use. Uncertainties as to the viability of preservation can best be assessed after stabilization. These last two alternatives can be viewed as two phases of one operation, with the second contingent upon the success of the first."

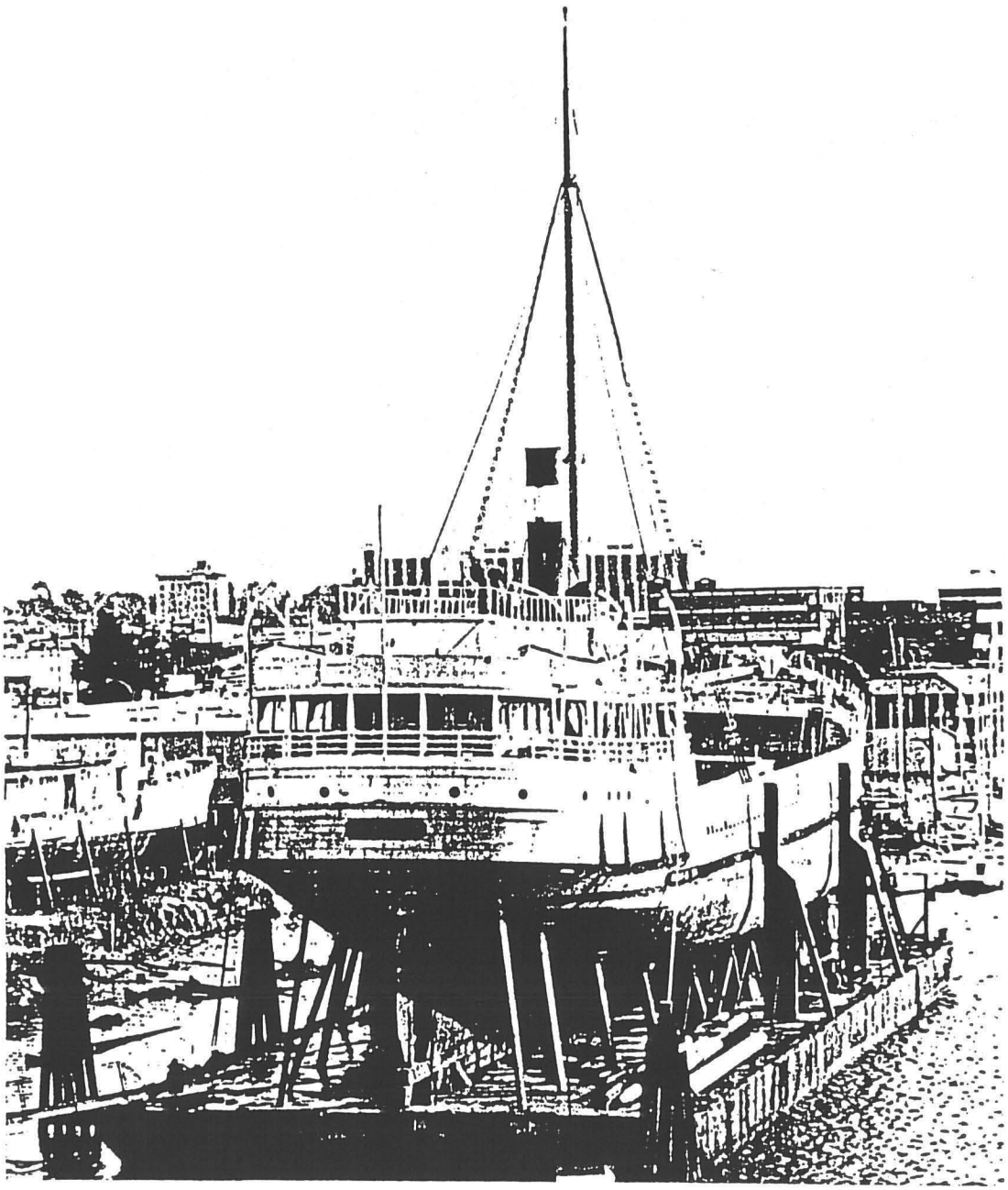
After assessment of the progress made toward stabilization of WAPAMA since the draft HSR was released, it has become clear that WAPAMA can indeed be preserved, and the success of this effort is contingent not so much upon any external variable, as upon the level of commitment the Museum puts forth. It is therefore recommended that the long term preservation with interpretation be viewed as a single, achievable, and worthy goal.

The basic requirements for preservation are increased structural support, protection from weather, and arresting rot. In addition to these, any plans to allow limited public access will require attention to issues of safety.



5. Summary of Existing Condition

WAPAMA is presently in a state of advanced deterioration for which there is no easy or quick cure. Rampant fungal decay is by far the the most significant cause of this deterioration. Severe structural weakening of the steam schooner necessitated her removal from the water in 1980. In the absence of ongoing maintenance, fungal decay went on virtually unchecked between 1980 and 1985. At present, decay permeates an estimated 80 percent of the structure. Recent efforts have resulted in some progress in slowing deterioration of the ship's structure, primarily through addition of supports and weather covers. Preserving the remaining historic fabric will require a greater commitment.



WAPAMA on Barge 214, 1985

6. Recommended Steps

a. stabilization

1) What has been done to date:

a) WAPAMA was dry docked on barge 214 in 1980. This action was taken to avoid the growing threat of hull failure and sinking.

b) Removal of masts, booms, forward winches and windlass took place between 1980-82. Relieving the structure of these loads lessened strains that were increasing local distortions.

c) A fabric and frame cover was built over the main deck and forecastle head in 1985. This was a first step to limit intrusion of rain water in these areas.

d) Increased shoring was placed under the main hatch, stern and main deck in 1985. This shoring was added to help support the cover and to resist further distortion of the hull.

e) In August of 1986, WAPAMA was shifted from Oakland Creek to the Corps of Engineers' Pier at the Bay Model Site. This site is currently available rent free with a sixty day termination clause; long term availability remains unknown.

f) A start on interpretation at the Bay Model has been made by production of a brochure and installation of wayside panels on the pier.

2) Additional Stabilization Work

a) The previous survey of the Barge 214 did not provide very much information on condition of the underwater shell. The barge was recently surveyed from the interior in order to assess the true condition of the bottom. Although the survey indicated that Barge 214 was not in immediate danger, the barge should still undergo a bottom inspection.

b) Additional interior and exterior support.

Recent contracts have provided additional shoring and support for bow, stern, deck beams, and stack. The vessel will need to be monitored during the stabilization period to determine if further shoring is required.

c) The ship's electrical system, formerly a corroded mess of original and modified wiring, has been upgraded to safe standards. The electrical system was also documented.

d) Safety upgrades

(1) The current access scaffold is suitable for workmen only. Any plans to allow public visitation must address this. Building stairs up from the hold and a stronger external stair or ramp is recommended.

(2) The current access scaffold is the sole egress from the vessel. From a fire safety standpoint a second egress should be provided. The simplest solution would be to place vertical steel ladders at bow and stern. Such egress would be suitable for workmen only.

(3) The engine room has crumbling asbestos insulation in many places that has fallen from rusted piping or crumbling boilers. Some of the piping is weak enough to be in danger of falling. This does not have to be addressed immediately if the engine room is kept off limits to visitors; staff should take due precautions when entering the area. Restoration of the engine room is considered a long term goal, some three to five years in the future, but asbestos abatement should be considered a safety priority

e) Coatings

(1) Machinery, boilers and tankage should be scaled, coated, and lubricated.

(2) Coating of weather surfaces is recommended for protection and improving appearance.

f) Rot arresting treatment

An inhouse study is currently being performed by U.S. Borax on the usefulness of large scale application of borates to arrest rot in WAPAMA's timbers. This path appears to offer the best combination of effectiveness and lack of toxicity to humans found to date. Continued funding of this program is recommended.

g) Increased Weather Protection

Improvement of the present weather protection is recommended. Options are as follows:

(1) Extension of the present type of cover over the entire vessel. Estimated Cost: $ 50,000

(2) Construction of a permanent shed over the entire vessel. Estimated Cost:
Barge modifications $200-250,000
Shed construction $200-350,000

(3) Partial restoration through renewals of weather surfaces.Estimated Cost : $1,000,000 to $2,000,000

Both the encompassing shed and the partial renewal options will require greatly increased funding, as well as design and construction time. The practical result will likely be a lead time of years rather than months. As the need for increased protection is immediate, extension of the present system is recommended so that the structure would be more fully protected while permanent solutions are being developed.

3) Further Studies

a) Complete documentation

(1) Take the lines of the WAPAMA

(2) Record historic fabric to be removed or altered. This should be done prior to removal of deteriorated piping and boiler breeching for safety considerations. Other equipment removals may become necessary during stabilization and should be preceded by documentation.

b) Experimental application of wood consolidation products and rot arresting treatments in selected locations.

c) Investigation of alternative siting should the Corps of Engineers require that the pier be vacated.

d) Survey Barge 214 during drydocking to establish suitability for long term storage of the WAPAMA.

e) Study availability and acquisition cost of an alternative to Barge 214 should the survey reveal serious structural problems, or lease/purchase negotiations fail to produce an acceptable arrangement. Part of this study would be designing and costing a procedure for shifting WAPAMA to another barge or site in the event that Barge 214 prove unusable for long term storage.

f) Design increased weather protection:

(1) Extension of temporary fabric-and-frame covers over more of vessel.

(2) Permanent shed structure.

(3) Modifications to Barge 214 to support permanent shed.

g) Design fire suppression system. (ventilation and drying will increase WAPAMA's vulnerability to fire.)

h) Update the vessel survey periodically to monitor the effectiveness of stabilization measures.

i) Design permanent structural support system.

j) Design interpretive scheme and modifications to permit public access.

4) Long Range Preservation with Onboard Interpretation.

We recommend that long term preservation be adopted as a goal but do not consider it feasible to develop a detailed plan beyond current recommendations at this time. Effectiveness of stabilization measures, long term suitability of Barge 214, and long term availability of a site will all need to be established before a definitive plan can be developed.

7. Table of Cost Projections

Recommended Sequence of Work: The Next Four Years

The following schedule is obviously flexible and some items may need to be deferred due to funding constraints. However, the condition of the WAPAMA is so marginal that saving her will require an unavoidable minimum level of effort each year. The items listed as "priority 1" are considered essential to the safety of the vessel.

FY 88: Priority 1 Stabilization

Reactivate shipboard fire mains	$ 1,000
Build additional covers over vessel	$ 50,000
Rot arresting treatment (borates)	$ 50,000
Minimum additional survey of barge shell by diver and internal ultrasonic testing	$ 3,000
Misc. repairs and maintenance	$ 5,000
Barge rental, 12 mo. @ $3,000 per	$ 36,000
Shipboard staff position, "engineer"	$ 15,000
Total for Year #1	**$ 160,000**

FY 89: Priority 2 Stabilization

Additional testing of rot treatment.	$ 15,000
Drydock Barge 214 for survey, maintenance and repair.	$ 140,000
Painting of ship exterior	$ 45,000
Machinery preservation	$ 10,000
Modifications to Barge 214: handrails,	$ 12,000
Misc. repairs and maintenance	$ 5,000
Build minimum public access	$ 50,000
Design permanent shed structure	$ 10,000
Load bearing study and hull support design	$ 15,000
Design public access	$ 10,000
Design sprinkler system	$ 3,000
Research wood consolidation methods.	$ 10,000
Design additional covers over vessel.	$ 2,000
Update survey, monitor change of condition.	$ 2,000
Shipboard staff position	$ 15,000
Barge rental or purchase	$ 36,000
Total for Year #2	**$ 380,000**

FY 90: Priority 3

Metal preservation (boiler, tanks, stack)	$ 22,000
Asbestos abatement	$ 35,000
Shipboard staff position, "engineer"	$ 15,000
Carry out Barge 214 modifications	$ 250,000
Build permanent shed on barge (Or commit this level of expenditure to weather surface renewals with equivalent expenditures carried into FY 90 and FY 91)	$ 350,000
Total for Year #3	**$ 772,000**

FY 91: Priority 4

Increase public access (includes partial renewals)	$ 300,000
Build permanent hull supports	$ 200,000
Develop interpretation	$ 150,000
Total for Year #4	**$ 650,000**
Total for Four-Year Program	$ 1,962,00

V. Preservation Requirements

A. Personnel

1. Staff

The fleet has never had sufficient staff for adequate maintenance or restoration. This lack has been in large part responsible for the downward spiral of deterioration which has left some ships in an unmaintainable condition. Unless major increases can be made in the work force permanently available for routine maintenance, even major restoration will only temporarily interrupt this downward spiral.

To accomplish the needed level of repair and restoration will require major increases in supervisory staff, even if heavy reliance is placed on outside contractors. The position of ship manager is necessary for coordination of the staff effort. The individual qualified for this position should be able to serve as Contracting Officer's Technical Representative (COR) on contract work, though this function itself will often need to be delegated or filled on contract.

The needs of some of the vessels are such that they cannot be deferred for many more years. Saving the ships will require that work be performed in a timely manner. To efficiently spend the sums recommended will require close supervision of several major projects running concurrently.

We therefore recommend that a knowledgeable person be placed in charge of each vessel, and that these "shipkeepers" report to a ship manager responsible for the entire fleet. The shipkeepers will be responsible for ongoing maintenance, coordinating volunteer efforts where appropriate, as well as serving as COR within the limits of their technical abilities.

Restoration of any one of these ships would be a major undertaking for any maritime museum in the country, requiring an adequate infrastructure for management. The management structure presently available will be totally overwhelmed by the volume of work needed by the fleet.

While a core group of craftspeople will continue to be needed to rotate from ship to ship, we recommend that each ship have its own crew, answering to its shipkeeper. There will always be a need for flexibility in shifting labor as needed, but a continuity of effort and a pride in the ship will best be fostered by specific individual responsibilities to a ship.

One member of each crew, either the shipkeeper or a senior subordinate, should be designated as the coordinator of volunteer work and must be available on weekends.

The following staffing level is recommended;

ALMA - Majority of crew to be privately hired by operator of passenger sailing program. One position to rotate among all ships crews.

BALCLUTHA:	1 shipkeeper 2 riggers 3 deck hands
EPPLETON HALL:	1 shipkeeper 1 mechanic/deck hand
EUREKA:	1 shipkeeper 1 engineer 2 deck hands
HERCULES:	1 shipkeeper 2 mechanic/deck hands
C.A.THAYER:	1 shipkeeper 2 rigger/deck hands
WAPAMA:	1 shipkeeper 2 deck hands
Small Craft:	1 boat builder 1 assistant

Allowance in the form of a few additional staff should be made for time lost to leaves, sickness or other absences, and for contingencies such as storm preparation. There should also be an unassigned pool of at least four shipwrights, one of whom needs to be a good caulker, and two shipfitters capable of riveting as well as welding. To support this effort, two more people will be needed for purchasing and storeskeeping. The ship manager will require a secretary and, at least part-time, a draftsman/designer.

This adds up to a work force of about forty people responsible for maintenance and restoration, without provision for security, janitorial, interpretation, research and documentation, special events and so on. Staffing for these functions has not been addressed as part of this Plan.

2. Volunteers

Volunteers can play an extremely important role in both restoration and maintenance. EPPLETON HALL, WAPAMA, and HERCULES currently have ongoing volunteer work programs which are making a significant improvement in the condition of the vessels. Maritime museums across the country depend heavily on volunteers for widely varying duties and percentages of total effort.

Administering a good volunteer program demands more management skill from staff than is required for dealing with employees. This is because volunteers are only there for the job satisfaction, whereas an economically dependent employee will be there, whether the job is satisfying or not. This is not to say that tasks have to be "fun" in the sense of avoiding hard and dirty work; prodigious amounts of such work are done by willing volunteers. What it does mean is that the volunteer has to feel that his or her time is being productively employed for the betterment of the ship. These people are giving of their leisure time. If volunteer projects are unnecessary or inefficiently run, if materials not available, if goals unrealistically set or repeatedly not met, the most productive people are likely to lose interest and drop out of the program.

Volunteers are likely to vary a great deal in their motivations for participation and in their skill level. Some will be there primarily for socialization, some from a commitment to historic preservation, some to live a fantasy, some to acquire or keep in practice a set of skills, and some to get outdoors and do something "high touch" rather than "high tech." Some volunteers, such as engineers, draftsman, machinists, finishers, will be providing high levels of craftsmanship. Others will lack nautical skills but may be extremely accomplished people in their professions, and fast learners. A few will have little to offer in the way of skills. This diversity of volunteers requires that their manager pay special attention to matching people with jobs.

Another important objective in administering a volunteer program is to achieve a clear understanding by both volunteers and staff of responsibilities, priorities, goals, standards, and timetables; in short, everything a production department of any business needs to know from management.

The more common pitfalls observed in institutions using volunteers are as follows:

a) Management may seek to use volunteers to compensate for inadequate funding, and build false expectations of what can be accomplished. Credibility is hard to establish and easy to lose.

b) The staff may not adequately credit the abilities of the volunteers and take an elitist attitude, dividing the "professionals" from the "weekend warriors". The frailty of human feeling is such that while praise must be loud indeed to be heard, the subtlest levels of contempt are perceived instantly.

c) Volunteers tend to overestimate their available time and energy, while underestimating the magnitude of the overall project. This may lead, for example, to taking things apart that cannot soon be put back together. Quite more often, false hopes are built up that a ship needs only minor work which can easily be accomplished in the near future. The result is disillusionment when time goes by and not much progress is seen. Perhaps the most discouraging situation is when a less essential job is done because it is easier to do, but has to be torn out later because the real need is for major repairs underneath.

It is essential for management and volunteers to understand the true requirements of a given project, make a commitment to achieving completion (at least of scheduled milestones if not the entire project), and communicate effectively.

A good place to start communicating is in the area of expectations. It is generally the case that on a major restoration project, (one that requires renewals more than refinishing), volunteers will accomplish no more than 10 to 20 % of the total work required. This is likely to hold true regardless of the skill level available. This is due primarily to the fact that ship repair projects often need to move forward quickly, as when the ship is on drydock or the deck torn up, and volunteers are usually available in quantity only on weekends. Major ship projects are measured in tens of thousands of hours, and take many months when done by scores of proficient people with all facilities at hand. Scheduling a project entirely on a volunteer timetable usually means stretching it over so many years that maintenance, overhead, and turnover of personnel negate any savings.

In the area of maintenance work, it is feasible for volunteers to have a larger role; sometimes more than 50% of a ship's routine maintenance can be handled by volunteers. In most of the hands-on operations of shipkeeping, i.e., washing decks, oiling woodwork, painting, tarring rigging, oiling machinery, opening and closing hatches for ventilation, etc., it is the consistency of the effort that counts the most. For many, such work is its own reward; the challenge for management is to keep interest and attendance up by varying projects and new experiences for participants.

3. Outside Professionals

If the Fleet Plan is approved, funded, and implemented, a gradual process of increasing in-house capabilities will take place. This will partially come from new hiring, and partially from the increasing experience level of existing staff. Such growth will take years. It is likely that the timetable required to save the ships will initially mean continuing the present reliance on outside contractors for most major projects.

The key to efficient utilization of contractors is to look past the obvious question of whether they have the capability of performing the work at all, to whether or not they have successfully performed similar work. In essence, how close are the bid specifications to the work they routinely do?

For piping, wiring, sandblasting, painting, or welded structural repairs, it makes sense to use commercial shipyards. For many items of woodwork, rigging, blacksmithing, etc., it makes no sense to go to a large modern yard. It will typically turn around and subcontract the work, so a higher overhead is paid for less direct control of the product.

On the positive side, an advantage to hiring professionals for various short term projects is that the staff and volunteers gain exposure to a variety of techniques and approaches. Hiring individual crafts people or small specialized companies on a project-by-project basis is highly recommended.

B. Berthing

1. Immediate Needs

The mooring arrangements of the vessels at present are adequate where open to inspection, but the condition of anchors and chains on the bottom of the Aquatic Park Lagoon and on the Fisherman's Wharf side of Hyde St. Pier is unknown. There are no adequate records of sizes, locations, and dates of placement of these anchors. As a matter of routine maintenance, all mooring anchors and cables should be inspected on a five year cycle.

Until a major rebuild or redevelopment of Hyde St. Pier can be undertaken, the following measures are recommended:

ALMA: Re-orient the vessel on a more east-west axis to reduce exposure to westerly winds and swell. Ideally, she should be moored to a float or barge, similarly anchored off the Hyde St. Pier and accessed by a long brow from the pier to the float. This would allow public access and greatly decrease the time required to get underway and remoor after sailing,as well as providing ease of access for maintenance staff.

EPPLETON HALL:
Re-orient the vessel as above. At present she rolls heavily from exposure to the westerly wind and swell. If a float were acquired for ALMA, EPPLETON HALL could be moored on the other side of it, sharing the brow to the pier.

BALCLUTHA:
BALCLUTHA's berth at Pier 43 had minor improvements made in 1986 but is considered unsafe in its present configuration. A decision was made in that year to move the ship to WAPAMA's former berth on the outer western side of Hyde St. Pier. For this move, the ship will require new moorings and modifications to shift the brow and utility umbilicals from starboard to port. The handrails at that portion of the pier will also require repair.

EUREKA: It is recommended that her present location, EUREKA's historic ferry slip, be retained. In the past, the ship has suffered damage to her rub rails, and inflicted damage to the inshore mooring dolphin because her mooring lines were out of adjustment. This situation has been corrected but requires monitoring and periodic re-adjustment. The bow anchor is due for inspection and resetting.

HERCULES:

The offshore anchors are of unknown size and the chains undersized and of limited scope. Resetting the offshore moorings with at least one ton anchors on two shots of 1-1/8" stud link chain is recommended. The inshore side is held by a ragged agglomeration of every conceivable kind. It appears adequate, if only through redundancy. If the ship is moved to Fort Mason for restoration work, a separate mooring plan will need to be developed. The Fort Mason site is noted for its considerable surge; a proper mooring system will therefore be important.

C.A.THAYER:

Her present mooring is a strong and well balanced one, provided that the offshore anchors are inspected and made good as needed. However, due to the severely weakened condition of the ship, it is recommended that some lines be shifted to locations closer to midships, thus reducing the pull of mooring chains at the ends of the vessel. Both measures are intended to reduce hogging strains and are described in detail in the Stabilization Measures. In addition, consideration should be given to moving the ship further out along the pier. The reason for this would be to reduce the amplitude of swells passing under her, and thus reduce the strains from the alternating hog-sag cycle she is now exposed to. The swell or wave height increases as the water shoals on the beach immediately astern of her. Shifting the ship will require building a new pier-side brow support.

WAPAMA:

In 1986, WAPAMA on Barge 214 was shifted to the Corps of Engineers pier in Sausalito and a strong mooring system installed. The present system is considered suitable, although an adequate brow is required.

2. Permanent Berthing: Hyde St. Pier Concept Plan

Permanent berthing for the historic fleet is addressed in The Hyde Street Concept Plan, a plan for the rebuilding and expansion of Hyde St. Pier. This plan was recently developed under separate contract by Architectural Resources Inc. with assistance from TCM. Detailed design work will be a major effort and will not begin until clarification is made of the long range waterfront plan for the Fisherman's Wharf area, and sources of funding for further studies are identified.

The case for the Hyde St. Pier as a permanent berth for the ships of the National Maritime Museum may be made as follows:

Berthing requirements for the historic ships must be addressed as part of any long range planning effort. Recent planning for a rebuilding of the Fisherman's Wharf area make it especially timely to discuss rebuilding the Hyde St. Pier and the relocation of the fleet.

The existing Hyde St. Pier is in need of repairs, but beyond its immediate physical condition is the question of its configuration. The existing pier is narrow and offers extremely limited space for repair work without unduly restricting public access. The pier is also in a very exposed location; the ships have suffered severe weathering from the westerlies, as well as from the strain of constant surging at their moorings. The pier is also too small to offer berthing alongside for the entire fleet.

Over the years various proposals have been discussed to relocate the fleet, and thereby overcome the limitations of the Hyde St. Pier. An important factor in these discussions has been that the pier is owned by the city and leased on a month to month basis by the Park Service. In accordance with policy restrictions, it has been impossible for the Park Service to spend funds on capital improvements, even if such funds had been available. It has therefore appeared more realistic to relocate the fleet to federally owned land.

The location that has received the most serious investigation is the west side of the Aquatic Park Lagoon. The primary advantages of this location are:

a) The land is federally owned.

b) There is more space available for shore-side facilities than at the present Hyde St. location.

c) The ships would benefit from the lee of the bluff, receiving protection from winds out of the west or southwest.

The disadvantages of this location are:

a) The amount of land available is very limited, compared to what may be made available through pier construction.

b) The west side of the lagoon is shallow, and dredging will be required. To what extent and depth it must be dredged, the environmental effects of such dredging, and at what rate silting can be expected to continue in the future, are questions that require further study. A dredging plan will have to investigate the possible undercutting of either the bulkhead, or Muni Pier itself.

c) While the bluff definitely makes a lee for the west side of the lagoon in a blow from that quarter, the effectiveness of the lee diminishes further out into the lagoon, and provides no protection from winds bearing north to east. If the fleet were moved, those ships closest in would receive some benefit, but those further out would enjoy little or no improvement.

d) The Muni Pier is not as effective in limiting surge as is the new breakwater. While the west side of the lagoon may have been quieter than the former conditions at Hyde St., the protection from wave action there is inferior to that now afforded by the breakwater.

e) Moving from Hyde St. means loss of the historic setting of the EUREKA at her working berth, and loss of the advantages of a location with extremely high tourist traffic.

Rebuilding Hyde St. to a new configuration presents the opportunity to solve several problems at once, and has the following advantages:

a) The protection from wave action given by the breakwater can be taken advantage of by relocating some of the vessels within the hook of the breakwater.

b) A rebuilt pier can accommodate the entire fleet as well as some visiting vessels. This will be a very important consideration if admission is charged.

c) A rebuilt pier can incorporate the needs of the fleet for improved maintenance facilities. Acquiring an increased capacity for on-site maintenance, repair, and restoration work is crucial for the long term survival of the fleet.

d) The sight lines in this location show the ships from a number of good vantage points ashore.

The construction of the breakwater has dramatically changed the parameters at Hyde Street. In combination with an enlarged and redesigned pier, this location offers the best compromises between the preservation needs of the fleet, and the aesthetic and historic aspects of the site. Preliminary design proposals are being made and evaluated by Architectural Resources, with participation by Tri-Coastal Marine under a separate work directive.

The key element in making such a scenario a reality will be cooperation between the City and the Park Service. The City must be made to understand that the long term preservation of the fleet and its full restoration is of benefit to the people of San Francisco, as well as the nation.

2. Lay Berth

The term "lay berth" refers to a pier at which above water line and interior repairs can be made while the ship is afloat. The primary requirements are a sufficiently strong pier to support cranes and heavy equipment deliveries, sufficient adjacent storage for materials, security, and quiet, well sheltered water to permit working off of floats alongside. This last is actually the most important and hardest to find in the Bay Area. The most likely place to find such a berth would be the Oakland estuary.

An adequate repair berth can and should be incorporated into the rebuilding of Hyde St. Pier. This will be preferable to having to maintain and staff two sites at widely separated locations. The one major restoration job that will be most efficiently done at a quiet lay berth is the rebuilding of EUREKA sponson decks. Even after rebuilding of the pier, the Fisherman's Wharf basin may not be calm enough to permit this work to be performed efficiently working off of a float. Rebuilding the sponsons may be cost efficient in a graving dock provided it is done concurrently with the major bottom work of recaulking and recoppering. Unfortunately, the cash flow may not permit such major projects to be done concurrently. Therefore it will likely remain most efficient to lease a pier at a remote location for the six months to a year required for this particular repair.

3. Shipyards

For routine cyclic maintenance of bottom coating systems, it will almost always be most efficient to rely on contracts with commercial shipyards. This will also be true for below waterline hull repairs that can only be done with the ship out of the water. BALCLUTHA and EUREKA will likely always be dependent on commercial facilities because of their size.

For major work on the smaller vessels, however, considerable savings could be realized if another barge similar to Barge 214 were acquired. Placing the vessel on the barge would require a double drydocking in a commercial shipyard as was done for WAPAMA. Refloating would require the reverse process.

With such a system, major rebuilding could be accomplished alongside of a shop facility at the rebuilt Hyde St. Pier. The vessel most likely to benefit from such a program would be C.A.THAYER. For repairs short of major rebuilding, the cost of the double dockings versus the savings in overhead in the repair would have to be examined on a case by case basis.

VI. Prioritized Preservation Plan with Cost Projection

FY 88: Phase 1. (Vessels are listed in order of Priority)

VESSEL	TASK	COST
ALMA	Repair centerboard trunk	$ 60,000
THAYER	Stabilization measures (Ref Survey)	$ 215,000
EUREKA	Repair end decks, peaks, and end-for-end ship	$ 805,000
WAPAMA	FY87 recommendations from HSR	$ 160,000
HERCULES	Stabilization Measures, drydocking, and further survey, drawings and restoration planning	$ 275,000
BALCLUTHA	Complete all deck repairs and upgrade electrical system	$ 225,000
EPPIE	Stabilization measures only	$ 95,000
Total Fleet Needs for Year One		**$ 1,835,000**

FY 89: Phase 2.

EUREKA	Recaulk and recopper	$ 1,200,000
THAYER	Planning, materials, barge.	$ 1,090,000
WAPAMA	FY88 recommendations from HSR	$ 380,000
HERCULES	Structural Hull Repairs and machinery repair sufficient for dock trials	$ 820,000
BALCLUTHA	Rig overhaul, bilge cement removal and coating	$ 1,055,000
ALMA	Repair stringers, keelson	$ 100,000
EPPIE	Restoration planning and remooring	$ 475,000
Total Fleet Needs for Year Two		**$ 5,120,000**

FY 90: Phase 3.

EUREKA	Rebuild superstructure and drydock for buoyancy chamber installation	$ 1,395,000
THAYER	Renew bulwarks, waterway, top futtocks, deck beams and decking and clamp, top strakes of planking (This will restore strength to top of hull girder)	$ 2,000,000
WAPAMA	FY89 recommendations from HSR	$ 772,000
ALMA	Complete hull repairs	$ 95,000
HERCULES	Complete work needed to get underway	$ 130,000
BALCLUTHA	Renew riveted stringers and 'tweendecks	$ 930,000
EPPIE	Begin major restoration	$ 215,000
Total Fleet Needs for Year Three		**$ 5,537,000**

FY 91: Phase 4.

THAYER	Complete the rebuilding	$ 2,000,000
ALMA	Upgrade vessel for passenger service	$ 65,000
HERCULES	Complete the restoration	$ 497,000
WAPAMA	FY90 recommendations from HSR	$ 650,000
EUREKA	Overhaul machinery and misc. repairs	$ 1,010,000
BALCLUTHA	Running rigging and some sails	$ 28,000
EPPIE	Complete the restoration	$ 298,000
Total Fleet Needs for Year Four		**$ 4,548,000**
TOTAL for Four-Year Plan		**$ 17,040,000**

Plan Execution

Costs have been estimated using a $40 per hour rate for those jobs that could only be done in a commercial shipyard. Other portions of the work that can be done alongside have been estimated using a $30 per hour rate, achievable by using smaller subcontractors or in-house staff. In terms of true overhead versus efficiency, the cost of staff labor and outside contractors are probably comparable.

In order to streamline contracting and purchasing, some projects have in the past been included in shipyard contracts, when they would have been better and more economically done under separate contracts with smaller contractors. If such a practice continues, the required quality of work may be unachievable and the cost at least 25% greater than projected above. Getting the best results will require close supervision by knowledgeable people; this will increase the management burden, but is unavoidable if the fleet is to be preserved.

Complicating the scheduling and managing of the restoration work will be the need to coordinate restoration efforts with the rebuilding of Hyde St. Pier. If the Pier is not rebuilt, a major effort will still be required to upgrade the mooring arrangements, and an improved maintenance facility and repair berth will have to be arranged elsewhere. Such an arrangement would carry the permanent cost of increased overhead in staffing, and maintenance of additional sites.

Establishing Priorities

The outlined priorities have been arranged to address critical needs first. If the tasks laid out for FY 88 cannot be accomplished in a timely manner (one to two years), the remainder of the plan will become less valid, and its goals far more difficult to achieve. Significant cost increases can be expected, at the very least. FY 89 tasks are also critical needs. Some of the work in FY 90, such as rebuilding EUREKA's superstructure, is equally critical. The majority of restoration work recommended for FY 90 and FY 91 could, if necessary, be spread over a longer timetable and still be achievable, but only if the critical problems were properly corrected and the ongoing maintenance upgraded.

The prioritization of vessels in each phase varies somewhat, but the wooden vessels are consistently in greater need. While this will probably always be so, it is especially true at the present, when uncorrected problems can rapidly worsen.

The ships with the greatest needs are C.A.THAYER and EUREKA. C.A. THAYER is in seriously weakened condition, with some degree of rot in nearly all major members. The priority should be to stabilize her condition in order to buy time for long term stabilization and restoration. EUREKA is in far better condition, but she is at the critical point where failure to arrest deteriorating conditions will have disastrous consequences.

It is recommended that resources be concentrated on restoration of EUREKA. Her condition is such that effort expended at this time will be largely preventative, forestalling serious deterioration. EUREKA is by far the largest wooden vessel in the fleet, at nearly twice WAPAMA's displacement and more than four times that of C.A.THAYER. If she is allowed to deteriorate to the condition of those vessels, the cost of her rebuilding would very likely be prohibitive.

The stabilization work on WAPAMA as recommended in the HSR is progressing, but already behind schedule due to the constraints of the FY 87 budget. For her stabilization to succeed, two important needs must be met: additional weather protection, and a rot treatment program.

The HERCULES survey found some critically thin areas of shell plating and a need for further inspection after bilge cleaning. Drydocking and implementation of the stabilization measures listed in the survey is recommended in the near future. HERCULES has great potential. She can be fully restored for less money than the larger vessels, and in cooperation with a private effort she could be a highly visible success in a relatively short period of time.

As a result of recent work, BALCLUTHA's hull is in the most stable condition of any ship in the fleet. The greatest threat to the fabric of the hull is internal corrosion caused primarily by water from leaking decks. If the unfinished portions of deck repair are carried out and the process of rigging overhaul accelerated, the ship will be maintainable without major renewal for many years to come.

EPPLETON HALL is in need of extensive restoration. The responsibility has been recognized to stabilize her until a policy decision can be made and implemented regarding her end use, or transfer to appropriate stewardship.

ALMA should undergo the work necessary to get her operational on a self-sustaining basis as soon as possible.

VII. Recommended Further Studies

A. Surveys, specifications, and planning.

Each vessel will require a detailed restoration plan. The following specific tasks must be undertaken to furnish the information needed to complete planning and cost estimating:

1. **ALMA** - Further inspection will determine the exact extent of structural renewals needed. Specifications will be required for this work, and for compliance with passenger vessel regulations if the sailing program is to be increased.

2. **BALCLUTHA** - Specification writing for the next repair contracts.

3. **EPPLETON HALL** - Should a decision be made to carry out work beyond stabilization measures, specifications will be required, as well as an estimate and feasibility study on boiler repair, or alternate steam sources.

4. **EUREKA** - Specification writing will be needed for phased renewals. It is also recommended that a weight take-off be made and a loading curve calculated. The purpose of such a study would be to determine the hogging and sagging strains imposed on the hull. This would permit design work to be done to increase buoyancy externally or increase ballast internally, in order to neutralize hogging or sagging.

5. **HERCULES** - A detailed restoration plan will be needed, including specifications, bills of material, estimates and schedules. Further survey work will be required during the next drydocking to determine the extent of necessary bottom shell renewals, and frame and foundation renewals after removal of the cement bilge lining.

6. **C.A.THAYER** - The bottom will require further survey work at the next drydocking. Specifications will be needed for repair contracts. A timber procurement effort will need to precede any extensive rebuilding. A weight take-off and loading curve study is even more important for this vessel than for EUREKA, and should be a high priority.

7. **WAPAMA** - Further stabilization work and any work to increase public access will require further specification writing and some drawings. The survey work will need to be updated periodically to monitor the success of stabilization efforts, particularly in arresting the spread of rot. Barge 214 will require further survey at its next drydocking.

In conjunction with development plans for rebuilding the Hyde St. Pier area, a feasibility study may be warranted for shifting the ship ashore or onto another platform. The HSR stated that WAPAMA was "married" to the barge. This is true to the extent that moving her will be difficult and entail some risk, and she should probably stay where she is for the next few years. However, in the context of a major urban construction project to create a permanent and satisfactory home for the fleet, the advantages may be sufficient to justify moving the ship.

B. Research

1. Continue the research advised in the WAPAMA HSR to determine the effectiveness and applicability of borates in arresting rot. Since major increases in funding for repairs will take some time to arrange and allocate any action that will arrest or retard rot is likely to be extremely cost effective.

2. A study is needed to identify and determine the effectiveness of various chemical treatments as rust modifiers or inhibitors. Such treatments could be extremely cost effective in interior areas, or in public areas where sandblasting would be difficult or inadvisable.

3. Continued study is needed to stay current in the evolving field of coatings technology; improvements are being made yearly in this field. Considering that nearly all maintenance work is related to applying coatings, or to the repair of damage that started with a breakdown of coatings, it is crucial to be sure the best paints, caulks, sealers, etc. are being used.

4. An investigation should be made into possible alternatives to copper sheathing the hull of EUREKA. Copper is expensive and not without drawbacks. Other methods are therefore worth exploring.

C. Drawings

A complete set of drawings, done to uniform standards, should be produced for each vessel. Even if no restoration work were needed, there would still be a responsibility to document the vessels in case of loss, or to aid in major repairs after a casualty. Some drawings already exist in varying levels of detail and accuracy. The following order of priorities is therefore recommended:

1. **C.A.THAYER** - This vessel is in need of major repair and could particularly benefit from additional buoyancy/ballast installation. The design work for this is best done from a lines drawing; a lines-taking can be done at the next drydocking. In addition, the existing midsection, outboard profile and main deck plan need to be ship checked for accuracy. A complete set needs to be developed after the aforementioned drawings are made and verified.

2. **ALMA** - A full set of drawings will be needed for submittal to the U.S. Coast Guard if it is decided to pursue inspected vessel status. At present, only a planking expansion and a sail plan are known to exist.

3. **EUREKA** - A partial set of drawings exists but does not include the lines, which should be taken at the next drydocking. As in the case of C.A.THAYER, the lines will be instrumental in developing a loading curve and a plan for neutralizing hogging and sagging strains. A complete set for documentation should be developed, as this vessel is most at risk to damage or loss by fire.

4. **HERCULES** - The only drawing that exists for this vessel is an inboard profile with major inaccuracies. Schematics are needed of the wiring and piping as soon as possible. It is also recommended that lines be taken at the next drydocking in order to develop a shell expansion as an aide in planning shell repairs. This vessel is not at great risk of loss, but a complete set of plans should be developed as part of the restoration plan.

5. **WAPAMA** - The lines were not taken during production of the HSR due to insufficient funding. Taking the lines will complete the documentation of this vessel.

6. **BALCLUTHA** - This ship is scheduled to be documented by HABS/HAER in 1987-1988, a project expected to take two or three summers to complete. A sail plan, deck plan, midsection, and shell expansion currently exist.
It is recommended that HAER give consideration to adopting some of the long established drawing conventions of naval architecture. Specific recommendations are:

    a) large arrangement drawings be done on oversize sheets that permit the entire length of the ship to be seen on one drawing;

    b) adherence to the common 1/4" = 1'0" scale, with details being done on a larger scale which are multiples, such as 1/2" or 1" to the foot.

7. **EPPLETON HALL** - The level of documentation will be determined by decisions of ultimate disposition, but at a minimum, a general arrangement drawing should be produced in order to aid in her stabilization.

VIII. Funding

A. Federal Budget

It is difficult to assess the likelihood of increased federal funding for the fleet of historic ships at the National Maritime Museum. It is hoped that this document will be helpful in calling attention to the value of the ships as a cultural resource, and in documenting the need for increased funding.

B. Private Sources

Fund raising by private non-profit corporations has never been attempted on a large scale in San Francisco to increase support for the ships. The best results in private funding may be obtained through cooperative agreements such as the one under which the JEREMIAH O'BRIEN Foundation is managed. Citizen groups with a particular interest can be highly motivated and active in supplementing government efforts. A matching grants program may be easiest to implement and the most successful. It is easier to justify government expenditure if there is a visible and demonstrated private commitment; it is easier in turn to raise private money if donors see their contributions leveraging larger amounts.

A variation of this theme that may serve as a pilot project would be to enter into "matching contracts" with volunteer groups for specific tasks on the ships. For example, the volunteers may commit to perform a certain amount or type of maintenance work that the Park Service would otherwise be obliged to allocate staff or contract for. In return, the Park Service could commit to spend the sum saved on another needed project that is beyond the capability of the volunteer group. The Park Service can make the available funds go further and the volunteers can see their efforts rewarded by improvements in the ships they serve.

A reasonable dividing line for cooperative agreement responsibilities may be for the Park Service to provide mooring, security, utilities, major structural repairs and maintenance sufficient for basic preservation. The private group can concentrate on aiding ongoing maintenance while raising funds and assistance for restoration, improvements, and special programs.

C. Earned Income

A major potential source of revenue is **earned income** from an admission fee charged at the entrance to Hyde St. Pier. This potential will only be realized by investing effort and money in a marketing plan, by increasing the visibility and attractiveness of the site, and through visible improvements in the ships.

Current visitation at Hyde St. is very low, in view of the density of pedestrian traffic less than a block away. The present entrance to the Pier creates the impression that it is closed rather than open. It is recessed from the street with a very narrow vista of the ships and does little to entice the average passerby.

The rationale for an admission charge is that the ships will be better maintained through increased revenues; an admission charge is in the public interest. If a charge is imposed with no concurrent effort at visible improvements however, visitation is likely to drop. Unless steps are taken to increase public awareness, the net result of charging admission will be an increase in staff and overhead while discouraging the interest that exists at present.

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